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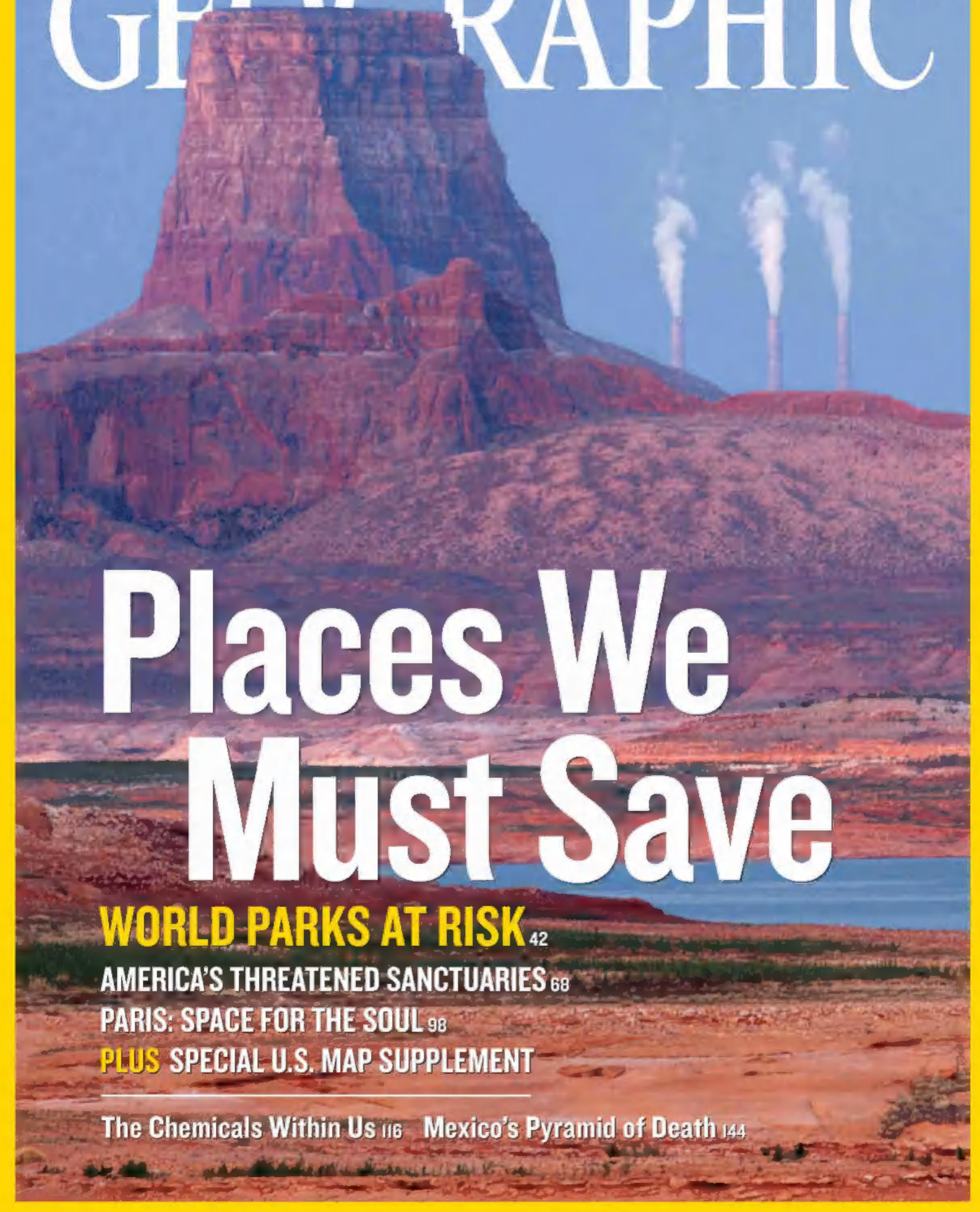
NATIONAL GEOGRAPHIC



Places We Must Save

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The Chemicals Within Us 116 Mexico's Pyramid of Death 144

Coast-to-Coast Mosaic

Colors on this map depict a wide range of land covers. The key at right shows each category distinctly; on the map the colors may blend where a variety of land covers overlap, such as in the Ozark Plateau, where forest mixes with croplands.

NATIONAL GEOGRAPHIC

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OCTOBER 2006

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The Volcanic Northwest

Mount St. Helens and sister mountains in the volcanic Cascade Range are geologic youngsters, born less than two million years ago. They are only the most recent expression of the region's volcanism, powered by an ocean plate diving under the continental plate. Starting 17 million years ago, one of the world's largest outpourings of basalt lava formed the vast Columbia Plateau. Nonvolcanic tectonic forces raised the Coast Ranges that front the Pacific.

Great Basin

Between the Rockies and the Sierra Nevada lies a unique North American landform called basin and range, where rough, steep mountains alternate with valleys covered with alluvial deposits. "Each range here is like a warship standing on its own," wrote John McPhee, "and the Great Basin is an ocean of loose sediment." It formed 20 million years ago when the crust stretched, thinned, and broke into blocks. The arid expanse includes Death Valley and the Great Salt Lake.

Rocky Mountains

Part of the grand cordillera spanning North and South America, the Rockies are the product of millions of years of tectonic uplift, glaciation, and erosion. They arose in two distinct phases. South Dakota's Black Hills and Wyoming's Bighorn Mountains date from the first tectonic shove, 70 million years ago. Thirty million years later, as uplifting created features such as the Tetons, the Front Range, and the Sangre de Cristo Mountains. More than 50 peaks exceed 14,000 feet in height.

Great Plains

Fertile sediments washing down from the eroding Rocky Mountains created the Great Plains, which cover nearly 20 percent of the lower 48 states. Arid enough to be scorned as the Great American Desert in the early 19th century, these rolling grasslands were transformed into farms and ranches that now produce half the nation's wheat and 40 percent of its beef, thanks largely to irrigation water drawn from the underlying Ogallala aquifer.

Legacy of Glaciers

Advancing and retreating over a span of hundreds of millions of years, mantles of ice reached farthest into the U.S. 18,000 years ago. By the time the last ice age ended 8,000 years later, glacial handiwork had created some of the country's most distinctive features: the Great Lakes, Puget Sound, the bogs of northern Minnesota, and the bulldozed flatness of the Central Lowland. There ice ground rock into the fine soil in which Iowa, Illinois, and adjacent states grow 40 percent of the world's corn crop. Sand and gravel deposited by glaciers also helped shape the profiles of Long Island and Cape Cod.

Appalachian Range

Among Earth's oldest mountains, this 1,800-mile-long range rose as land folded and faulted during a series of collisions between North America and other landmasses 480 to 250 million years ago. Relentless erosion by water and, in the north, glaciers shaped the range and valleys and reduced its highest point—North Carolina's Mount Mitchell—to only 6,684 feet. Parallel ridges marching off the range's western flank are striking remnants of once towering peaks. From Vermont's Green Mountains to the Great Smokies, all the East's mountains except the Adirondacks are Appalachian. The Adirondacks were first raised during a collision of landmasses perhaps a billion years ago, though today's range, rounded by glaciers, dates from a rejuvenating uplift about 40 million years ago.

Coastal Plain and Piedmont

Sweeping 3,000 miles along the Gulf Coast and up the Atlantic seaboard, the Coastal Plain is an extension of the submerged continental shelf. The sea repeatedly covered this plain in ages past, depositing sediments and lapping against the foothill plateau called the Piedmont. Where rivers drop over the Piedmont's fall line, waterfalls powered industries that fueled the rise of cities such as Philadelphia, Baltimore, and Richmond. Today the stretch from Washington, D.C., to Boston has been called Megalopolis, the country's most densely populated region, with more than 40 million people.

Yellowstone Hot Spot

The hot spot that powers geysers in Yellowstone National Park produced monumental lava eruptions there during the past two million years. Lava that created the Snake River Plain, starting 17 million years ago, flowed from volcanoes that were once atop the hot spot, which remains stationary as the North American plate moves westward.

Continental Divide

The Continental Divide runs the length of the Rockies, marking the boundary between watersheds that drain to the Atlantic and Pacific Oceans. The divide splits along ridges around the Great Divide Basin, from which water cannot flow to the sea, but only sinks into the sand or evaporates.

Black Hills

When the Black Hills were raised during the initial building of the Rockies, their face was an ancient limestone seabed. Erosion exposed the billion-plus-year-old granite beneath, into which the faces on Mount Rushmore are carved.

Nebraska Sand Hills

The largest dune field in the Western Hemisphere, the Sand Hills formed 10,000 years ago.

Coteau des Prairies

The flattop-shaped plateau of Coteau des Prairies—900 feet of accumulated glacial deposits—was left standing when glaciers of the last ice age parted around it, following old streambeds along its base of resistant shale.

Driftless Area

The hills of southwestern Wisconsin were, by chance, untouched when glaciers last covered the Midwest. Geologists call this the Driftless Area because it holds no recent glacial deposits, or drift.

Black Belt

Chalky remains of seashells deposited when this was an ocean shore during the age of dinosaurs mixed with clay to create a crescent of rich, black soil in Mississippi and Alabama.

Florida

Bedrock reveals that Florida was part of Africa before ancient landmasses merged to form the supercontinent Pangaea about 300 million years ago. When Pangaea broke apart 200 million years ago, creating the Atlantic Ocean, Florida stayed attached to North America.

Mississippi River

A great crustal rifting some 600 million years ago failed to tear the continent apart, but did provide a passage for the future Mississippi River. The rifting also created seismic instability that is still a threat today. In 1811-1812 it caused some of the most powerful earthquakes in U.S. history, centered near New Madrid, Missouri, and felt as far away as New York and South Carolina. The ever shifting Mississippi has formed at least seven major deltas over the past 9,000 years; the current delta began building about A.D. 1400.

Ozark Plateau

The Ozark Plateau and the Boston Mountains were uplifted and folded during one of the continental collisions that formed the Appalachians. The Ouachita Mountains were once connected to the Appalachians. The separation began 200 million years ago as North and South America drifted apart and created the Gulf of Mexico. High sea levels then covered the area between the ranges with sediments miles deep.

Texas Hill Country

The Texas Hill Country, on the Edwards Plateau, is eroded limestone laid down 100 million years ago when the region was sea floor. The weight of sediments later deposited from the eroding Rockies helped create faults that broke the land into stairstepping escarpments.

Colorado Plateau

Escaping the tectonic wrenching that created the Great Basin and the Rockies, the Colorado Plateau was elevated as an intact block beginning about 20 million years ago. The erosive power of water transformed the plateau into formations so spectacular that some 30 parks and preserves bear their names. Among them: Monument Valley, Zion, Bryce Canyon, Arches, and the Grand Canyon.

Grand Canyon

Rock layers in the canyon display nearly two billion years of geologic history.

California Central Valley

Five million years ago the 400-mile-long Central Valley was an inland sea, trapped as tectonic uplift created the Sierra Nevada and the Coast Ranges. When shifting along the San Andreas Fault tilted the valley 600,000 years ago, the waters flooded westward, helping shape the basin that later became San Francisco Bay. Left behind: fertile sediments that had eroded from surrounding mountains, making today's Central Valley the chief engine of California's prodigious agricultural output.

Alaska

No state feels more earthquakes than Alaska, where the Pacific plate rapidly dives under the North American plate. The tectonic clash raised Mount McKinley (Denali), at 20,320 feet the highest mountain in the U.S., as well as the nation's next 16 highest mountains. More than 75 volcanoes dot the trailing tail of the Alaska Peninsula and the Aleutian Islands. Glaciers carved the rugged coastal profile and smoothed the far north.

Hawaiian Islands

The archipelago was born explosively, one island at a time, as the Pacific plate drifted over a hot spot in Earth's mantle. The volcanically active Big Island is about 700,000 years old and moving northwest at about four inches a year. Next to rise from the hot spot: A seamount called Lō'ihi is building and should surface in about 50,000 years.

THE UNITED STATES
History of the Land

"On a clear day a transcontinental flight can indeed be 'the greatest show on earth,'" marveled the late Walter Sullivan, prominent science writer and author of *Landprints*, who valued a window seat as a portal to the epic drama of U.S. geologic history. "The traces of the past are there to be seen . . . if one knows how to read them."

Viewed in one sweep on a topographic map, the country seems roughly divided into a jagged mountainous West, a central rolling prairie, and an East both muscled by the Appalachians and soothed by the Coastal Plain. Grand forces shaped those broad stages: Tectonic energies began lifting the Rockies 70 million years ago and still power the volcanically active Cascades. Eons of repeated glaciation ironed the continent's midsection. The now eroded Appalachians may have been as high as the Himalaya when formed by the crash of primeval continents starting 480 million years ago. Within these stories intriguing geologic subplots have unfolded: Relentless lava flows laid the crescent of Idaho's Snake River Plain; windblown remains of dead riverbeds were reincarnated as Nebraska's Sand Hills; and the erosion of marble underlying the East River and Harlem River has left Manhattan an island.

SCALE 1:5,200,000
1 CENTIMETER = 52 KILOMETERS, 1 INCH = 83 MILES

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Supplement to the October 2006 National Geographic magazine. For information regarding available maps call 1-800-963-1648 or write to National Geographic Maps, PO Box 4307, Evergreen, CO 80437-4307. You can find us on the Internet at **nationalgeographic.com/maps.**


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KANSAS
OKLAHOMA
TEXAS
MINNESOTA
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GULF OF MEXICO
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Mount Rainier National Park
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North Cascades National Park
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Sequoia National Park
Kings Canyon National Park
Death Valley National Park
Joshua Tree National Park
Grand Canyon National Park
Zion National Park
Bryce Canyon National Park
Arches National Park
Canyonlands National Park
Capitol Reef National Park
Great Sand Dunes National Park
Mesa Verde National Park
Rocky Mountain National Park
Badlands National Park
Wind Cave National Park
Theodore Roosevelt National Park
Voyageurs National Park
Isle Royale National Park
Pictured Rocks National Lakeshore
Indiana Dunes National Lakeshore
Sleeping Bear Dunes National Lakeshore
Apostle Islands National Lakeshore
Mammoth Cave National Park
Great Smoky Mountains National Park
Shenandoah National Park
Acadia National Park
Cape Cod National Seashore
Everglades National Park
Biscayne National Park
Dry Tortugas National Park
Big Bend National Park
Guadalupe Mountains National Park
Carlsbad Caverns National Park
White Sands National Monument
Petrified Forest National Park
Saguaro National Park
Organ Pipe Cactus National Monument
Channel Islands National Park
Pinnacles National Park
Lassen Volcanic National Park
Mount Rainier
Mount Hood
Mount Shasta
Mount Whitney
Death Valley
Great Salt Lake
Salton Sea
Lake Tahoe
Lake Mead
Lake Powell
Lake Michigan
Lake Erie
Lake Ontario
Lake Superior
Lake Huron
Lake Okeechobee
Chesapeake Bay
Delaware Bay
Hudson River
Mississippi River
Missouri River
Ohio River
Rio Grande
Colorado River
Columbia River
Snake River
Yukon River
Brooks Range
North Slope
Aleutian Range
Alaska Range
Wrangell Mountains
Kenai Mountains
Chugach Mountains
Juneau
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Maui
Molokai
Lanai
Hawaii
Kilauea
Mauna Loa
Mauna Kea
Haleakala
Edwards Plateau
Ozark Plateau
Appalachian Mountains
Blue Ridge Mountains
Great Smoky Mountains
Adirondack Mountains
White Mountains
Green Mountains
Catskill Mountains
Allegheny Mountains
Cumberland Plateau
Piedmont
Coastal Plain
Everglades
Okefenokee Swamp
Great Dismal Swamp
Florida Keys
Outer Banks
Cape Hatteras
Cape Cod
Cape Canaveral
Cape Kennedy
Cape Fear
Cape Henry
Cape May
Long Island
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Yukon Territory
Northwest Territories
Nunavut
Abbreviations
Map Legend
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Divided highway
Other road
Canal
Ferry
Airport
National capital
State capital
Sand
Lava
Glacier
Intermittent lake
Dry lake
Swamp
Below sea level
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The United States

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THE PURSUIT OF PERFECTION

Mountain Plover *(Charadrius montanus)*
Size: Length, 21 - 23.5 cm; wingspan, approx. 58 cm
Weight: 90 -110 g **Habitat:** Short-grass prairie, grazed areas and freshly plowed fields
Surviving number: Estimated at 8,000 - 10,000

Photographed by Michael Forsberg

WILDLIFE AS CANON SEES IT

Now you see it, now you don't. By simply turning its back to an intruder and squatting down, the mountain plover is able to virtually vanish into the landscape, a faculty that has earned it the nickname "prairie ghost." The elusive bird is equally adept at advertising its presence to declare and defend its territory during breeding season; one display involves flying five to ten meters in the air, locking its wings and calling as it floats downward like a falling leaf. Nesting on both rangeland and cropland, the mountain plover is vulnerable to predation and agricultural practices. As a result, its vanishing act is fast becoming more than an act.

As an active, committed global corporation, we join worldwide efforts to promote awareness of endangered species. Just one way we are working to make the world a better place—today and tomorrow. Visit **ngm.com/canonwildlife** to find out more.

Canon

NATIONAL GEOGRAPHIC

OCTOBER 2006 • VOL. 210 • NO. 4

Waterfalls of Iguaçu National Park stretch for more than a mile across the Iguaçu River where Brazil meets Argentina.

FRANS LANTING

Features

COVER A coal-burning power plant clouds the sky over Utah's Glen Canyon National Recreation Area. **PHOTO BY MICHAEL MELFORD**

♻ Cover printed on recycled-content paper

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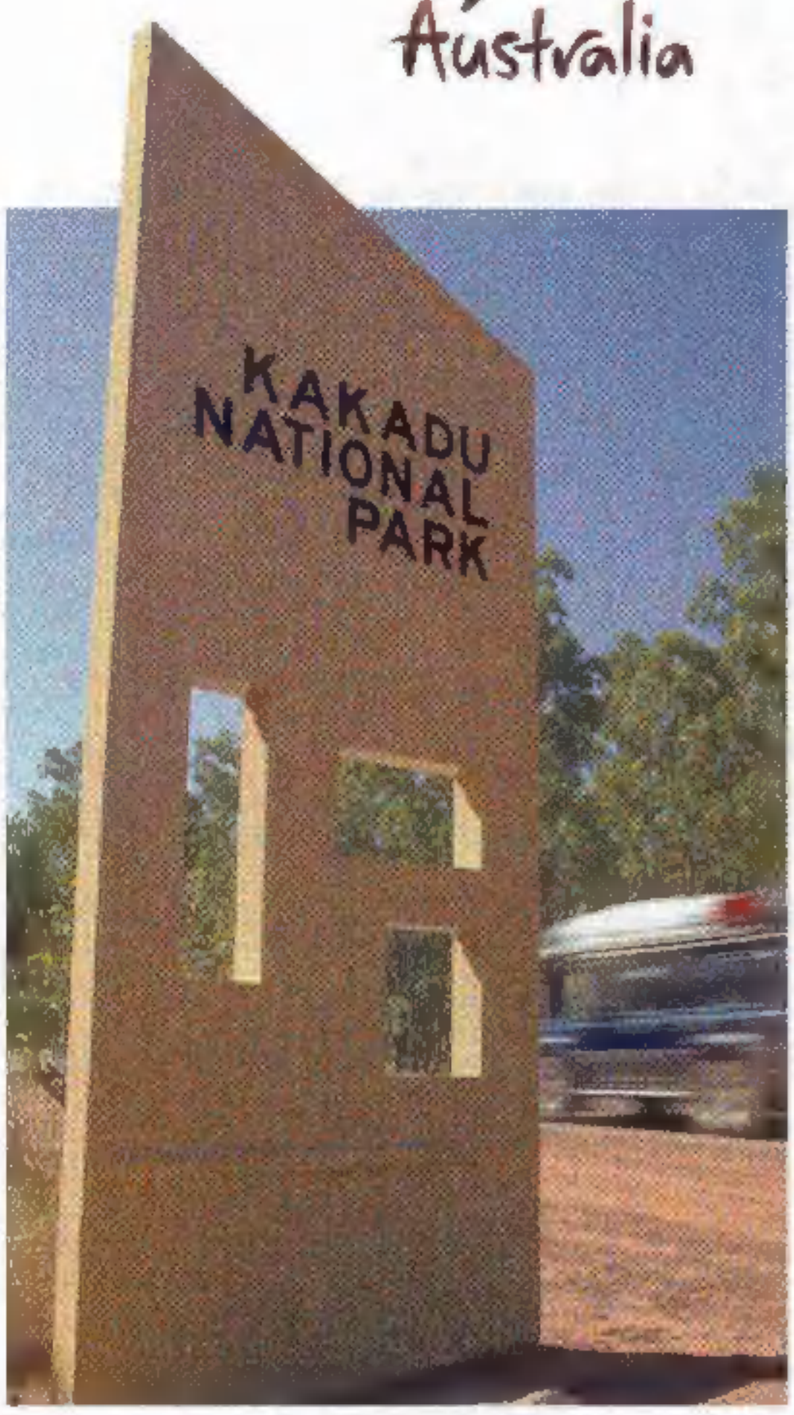
Australia



The call of nature

Kakadu National Park in the Northern Territory is one of the world's greatest natural treasures. A new National Geographic webcam allows you to find out what you're missing and become an expert...

There's nowhere else on earth like Kakadu National Park. The moment you drive through the gates, you enter an ancient territory that's teeming with wildlife – a place where humans have been living in harmony with the environment for approximately 40,000 years. According to Aboriginal belief, Kakadu was shaped by the spiritual ancestors who roamed the planet during the Creation Time. Along the way they established one of the most diverse ecosystems on the planet, providing a haven for the 500 species of mammals, birds and reptiles that live here. Within this vast swath of land the size of Belgium, you'll find open grassland, intricate waterways, floodplains and rock escarpments – stretching on as far as the eye can see. In a world where unspoilt land is becoming increasingly rare, Kakadu is a true blue Australian treasure. Whether you're a casual observer of wildlife or a keen naturalist, you'll see sights here that will take your breath away. Within a matter of hours we saw egrets and estuarine crocodiles, kangaroos bouncing through the bush and the magnificent sight of a sea eagle soaring high above the mangroves at Yellow Water. Everything here has a special place; the best way to find out about it all is to ask an expert...

Become a Kakadu expert

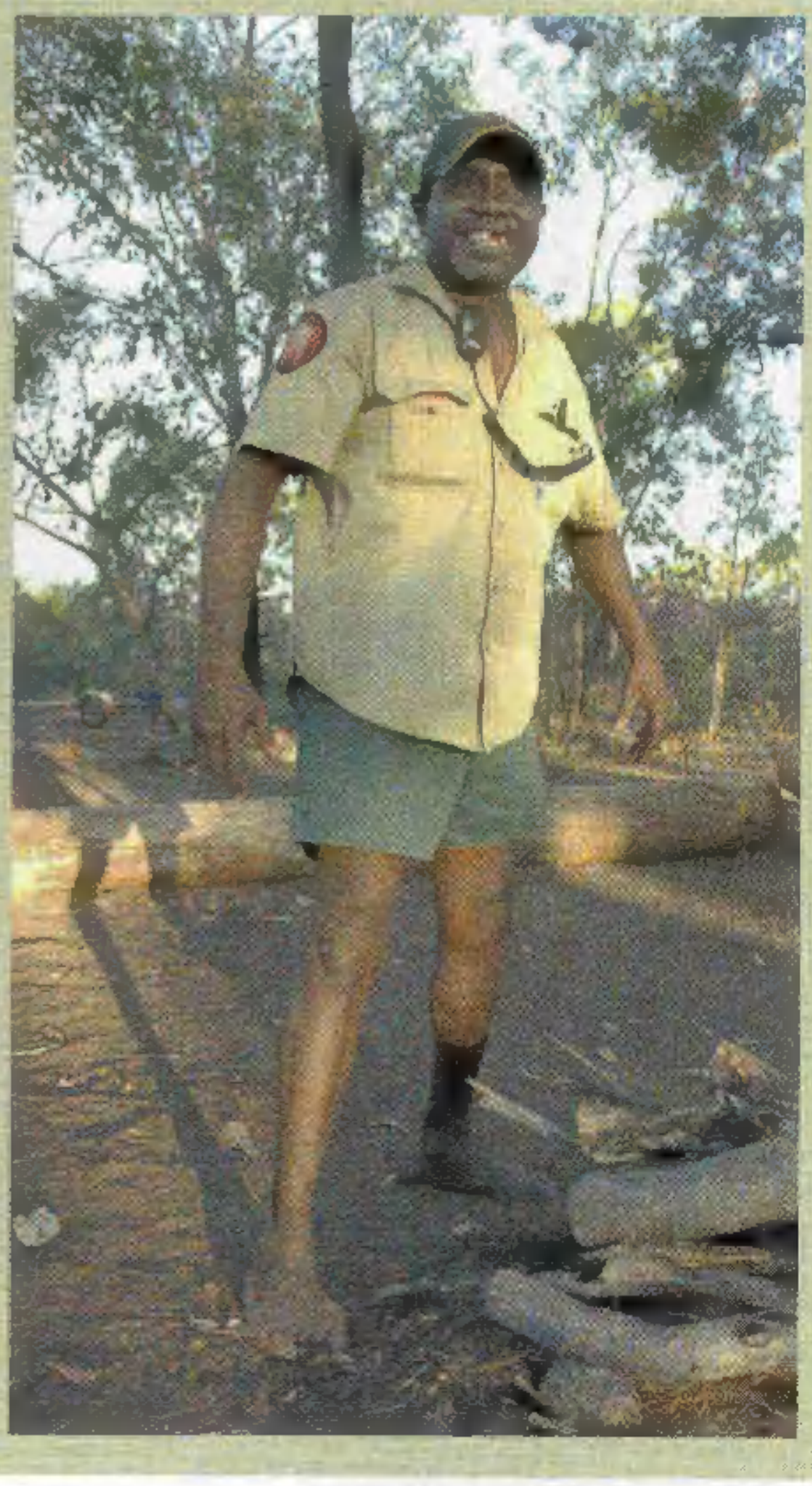
National Geographic, in association with Tourism Australia, has set up a special webcam at the Mamukala Wetlands in Kakadu National Park. To glimpse some of the Kakadu magic, all you have to do is visit:
www.ngm.com/kakaducam/

Clockwise from left: gateway to 20,000 square kilometres of World Heritage National Park; site of the new 'Kakadu cam' at Mamukala Wetlands; expert naturalist and Kakadu resident Johnny Reid

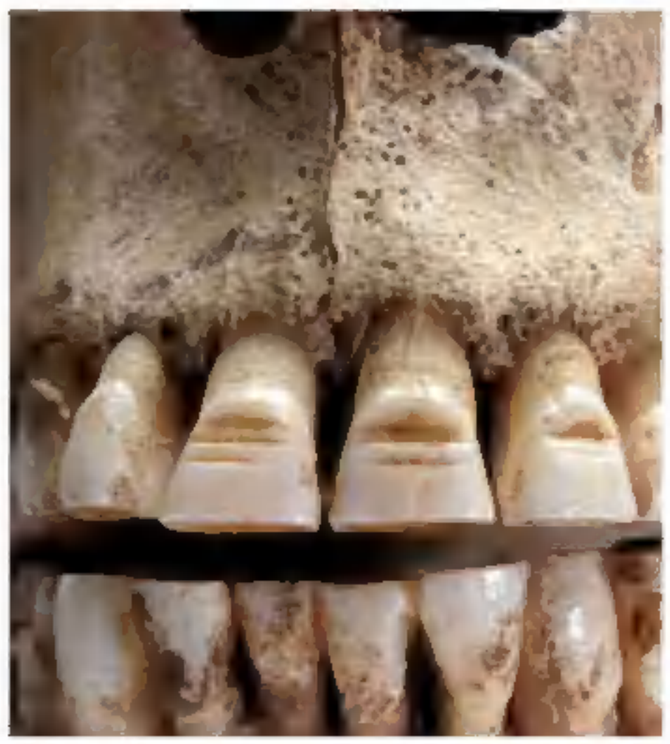
Johnny Reid
"Naturalist"

Kakadu National Park, Northern Territory

Few people know more about the world around them than Johnny Reid. His knowledge cannot be learnt in any university, however – it is hardwired into his system by the generations of his family who have lived on this sacred land for thousands of years. You'll find him at Sandy billabong, where he works as a guide with the Kakadu Culture Camp. Padding through the bush in bare feet, he points out things that you'd normally never notice. "That tree over there is a paper bark tree; you can use it to build canoes and huts. And the stalk of that water lily can be sliced up and eaten; it's delicious." Kakadu is full of experts like Johnny, people who can tell you more about this land than the scientists ever will.



> Johnny's knowledge cannot be learnt in any university – it is hard-wired into his system.



On the Web

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WildCam Africa
See live footage of leopards, hyenas, and giraffes at a watering hole in Botswana. Join the blog and talk with park rangers about the daily action at ngm.com/wildcamafrica.

Parks of the World
Explore our archive of park stories, listen to Nelson Mandela describe his dream of "Peace Parks," and download spectacular desktop wallpaper at ngm.com/parks.

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PHOTOS: REBECCA HALE, NGS STAFF (LEFT); STAFFAN HYLL (CENTER); FRED BAVENDAM, MINDEN PICTURES (RIGHT)

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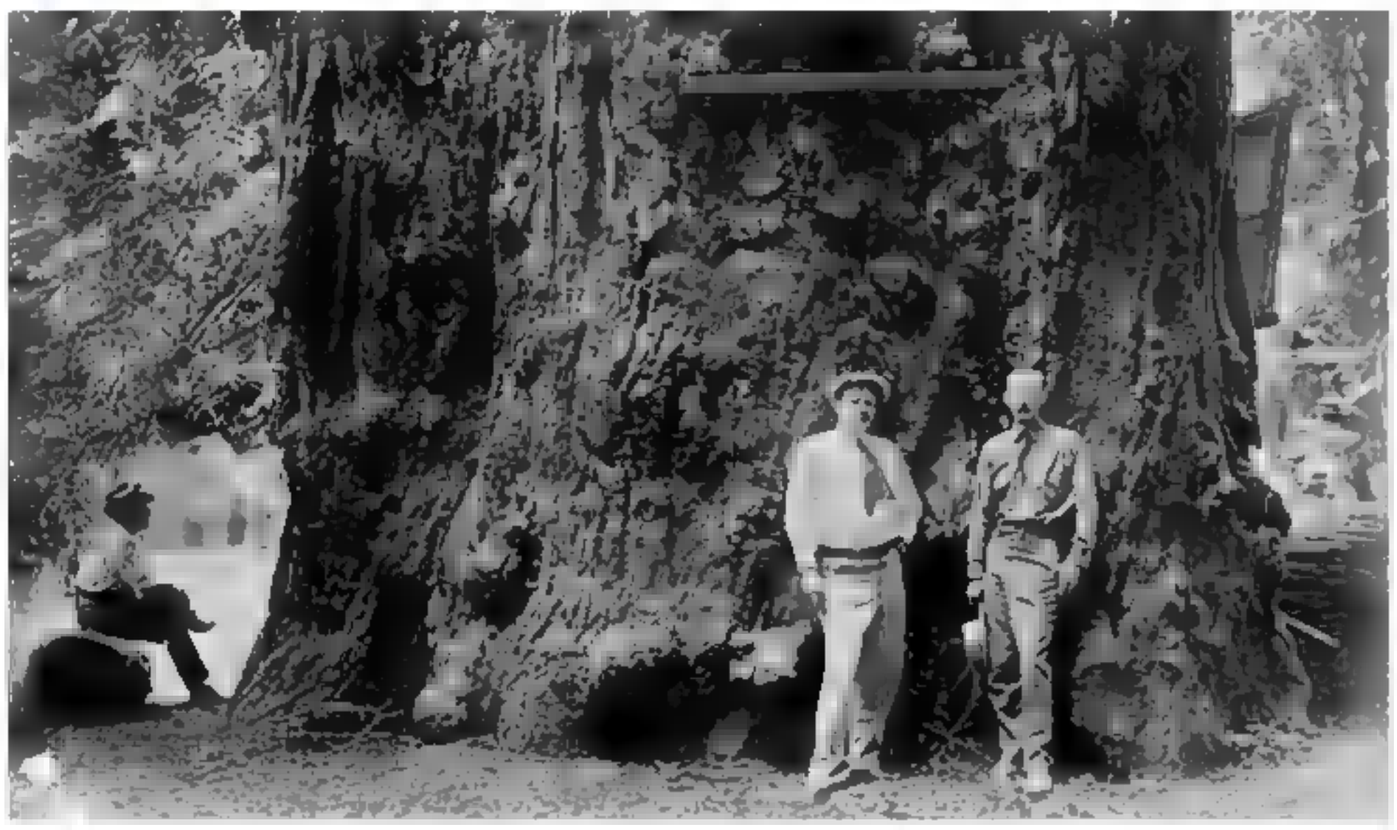

Saving the big trees of northern California was a passion of GEOGRAPHIC Editor Gilbert H. Grosvenor, at right, with writer Jack London, in 1915.

If you don't like the weather, wait a minute, locals in southeast Alaska say. With a helicopter on call, I'd waited weeks, not minutes, for the weather to let up enough to install a remote camera on a cliff overlooking Yakutat Bay. Despite relentless rain, the pilot finally gave it a go. As we flew over the ridge, clouds broke to reveal the most spectacular landscape I'd ever seen. Hubbard Glacier and snow-clad Mount Hubbard loomed ahead; Russell Fiord gleamed off to the right. This is National Geographic country, site of the Society's first expedition, in 1890. Mount Hubbard and its glacier are named after Gardiner Greene Hubbard, the Society's first president. Russell Fiord bears the name of geologist Israel C. Russell, another Society founder. The May 1891 article on that expedition called attention to what would become Wrangell-St. Elias National Park. In 1916, we helped save another magnificent landscape: When lack of funding jeopardized the founding of California's Sequoia National Park, the Society made up the shortfall.

More recently, our coverage of Mike Fay's 2,000-mile Megatransect through central Africa resulted in 13 new national parks in Gabon. And, on June 15, 2006, President Bush announced creation of the Northwestern Hawaiian Islands Marine National Monument —at 140,000 square miles, an area greater than all of America's national parks combined. A White House aide said that the President and First Lady had been amazed by the photos of the Northwest Hawaiian Islands that appeared in the October 2005 GEOGRAPHIC.

To examine the state of the world's protected areas is a pressing mandate. Will they be there for future generations? In this 118th year of the magazine's publication, we at NATIONAL GEOGRAPHIC are redoubling our commitment to "Places We Must Save."

PHOTO: GABRIEL MOULIN

WELCOME

TO THE

DEPTHS OF THE

OCEANS

ROLEX

MAKES WALKING ON THE MOON

BEEM PEDESTRIAN

ROLEX


the
record under
a of
feet
as "Her
has more
than underwater marine
metres, she
also the women's for
in a
Doubilet has
of life
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[illegible] THE SEA-DWELLER

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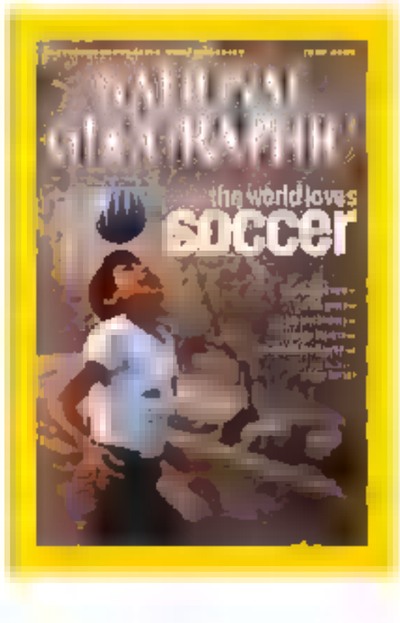
LETTERS



June 2006 *Among international readers there was a consensus about "The World's Game." They disagreed with the story's use of the term "soccer" instead of "football." Editor in Chief Chris Johns had anticipated the response. "For many of our readers," he explains, "the term 'football' means a different sport from soccer. 'Soccer' only means soccer."*

Comment on October stories at **ngm.com.**

The World's Game

Sean Wilsey considers money and God to be the two most relevant factors in helping us understand the phenomenon of soccer. Yes, a small group of players and an even smaller group of owners may be financially motivated, but for the hundreds of millions who play this game every day, it is simply the thrill of a pass that catches a player in stride, the satisfaction of ■ header that lands just where it was intended, and the elation of scoring a goal.

STAN DUBIN
Clearwater, Florida

When a fan paints his head in the colors of his country's flag with "Italia" written ear to ear, it's considered national devotion. When flare-wielding fans in Athens disputed a penalty, threw rocks, attacked a referee, and ripped out seats, that was merely tribal violence. When a riot erupted in Croatia during a match, it was described as political passion. Yet when Americans, who are just as proud of their team as any other country, began a nonviolent chant, "U.S.A.! U.S.A.!," that's just too much. They've gone overboard, and they are considered the irritating fans. We who are loyal to the U.S. just can't win.

PERRY WILSON
Phoenix, Arizona

It is true that soccer is not as big a sport here as in some other countries. It is also true that we have not won a men's World Cup (yet). But to U.S. soccer fans it is a great sport. We do not need to be mocked because many of our countrymen have other sporting passions. So get over the prejudice about U.S. soccer, and instead celebrate that the U.S. qualified for its fifth men's World Cup in ■ row, and that the U.S. women's team has won two World Cups. Countries like the U.S., with growing interest in the sport, help make it a beautiful game.

MIKE GILMORE
York, Pennsylvania

Excuse me, but the world loves football, not soccer. To describe the World Cup as the Soccer World Cup is like describing the Olympics as the World Running and Jumping Tournament. In America it may be soccer, but to billions worldwide, it is, and always will be, football.

IAN BENFORD
Lincoln, England

I applaud your essays on the world's only true game. However, you failed to examine the bigger picture of soccer's impact on sporting diplomacy. It was in 1999 that the United Nations recognized the power of soccer by locking arms with FIFA and subsequently dedicating the 2002 World Cup in Korea and Japan to children. That partnership has been growing stronger ever since and reached a pinnacle in January this year when Secretary-General Kofi Annan visited FIFA's Zürich headquarters and signaled the UN's intent to strengthen a strategic partnership with the sporting world.

STEVE MUENCH
Livingston, New Jersey

Excluded from even the smallest mention is the very brilliant, hardworking, wonderful team from Trinidad and Tobago. Seems to me some acknowledgment should have been made of the smallest country to qualify and to be in the ranks of the famous players competing in Germany this year.

GLORIA T. BAILEY
Scottsdale, Arizona

Many fans wrote to mention teams, games, and players not included in the story, such as the Iranian national team, the 1953 game in which Hungary beat England, and one of the sport's

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LETTERS

first superstars, Ferenc Puskás, who played for Hungary in that 1953 match and later played for Spain's Real Madrid.

Hutterite Sojourn

I have been reading your magazine for ■ few years now and always enjoy it. Rarely have I read an article with the kind of private side that Bill Allard showed us in his Hutterites of Montana story. He introduced us to the colony through his long connection with them, and he allowed us a glimpse into the personal tragedy of his son's death. I felt drawn into the story in a way that isn't typical of articles I read. This man is a highly talented photographer, but his writing is equally compelling. What a gift.

KATELL G. ZAPPA
Watertown, Massachusetts

Apparently the writer feels "comfort" in a society that is religiously intolerant, treats women as chattel, and does not welcome people of other races. I agree with him on one thing. The Surprise Creek Colony is a paradise—if you are an Anglo male.

LUIS PANDO
Pasadena, California

As an animal advocate, I must protest the pictures on page 131 that depict the slaughter of chickens and pigs. Showing animal heads severed from their bodies was not in good taste. I realize that this is part of the Hutterite lifestyle, but I don't believe the pictures were necessary to the article.

MARILYN EVENSON
Tacoma, Washington

When I read about the Hutterites, I couldn't help but feel privileged. It was a rare occasion to have a glimpse of how the colony operates, both spiritually and physically.

ORVILLE BECKING
Snow Lake, Manitoba

Nanotechnology

Your article explores the potential benefits of the technology, but only a few of the potential health and environment problems. It ignored one place that many people may already be experiencing harm from nanoparticles—in consumer products such as cosmetics and sunscreen. More than 200 products marketed in the U.S. contain nanoparticles; yet, the Food and Drug Administration does not require any nano-specific safety testing. Our organization and a coalition of consumer, health, and environmental organizations have petitioned the FDA to regulate nanomaterials as new substances because of their fundamentally different chemical and physical properties, and to require nano-specific safety testing and product labeling.

JAYDEE HANSON
GEORGE KIMBRELL
International Center for Technology Assessment, Washington, D.C.

Corrections, Clarifications

Nanotechnology (June 2006)
Malaria is caused by a parasite, not a virus, as we said on page 108. The error was corrected on press in half our issues.

Hutterite Sojourn (June 2006)
Although Hutterites refer to their everyday language as Low German, as we mention on page 122, linguists use that term to refer to northern German dialects. Hutterite German originated in southern Austria and has a number of loan words from Slavic languages and English.

What moves you?

Climbing a mountain, fording a stream, being master of all you survey? Whatever it is, Cathay Pacific can help you get there. We fly to over 90 international destinations, so there will always be new worlds for you to conquer.

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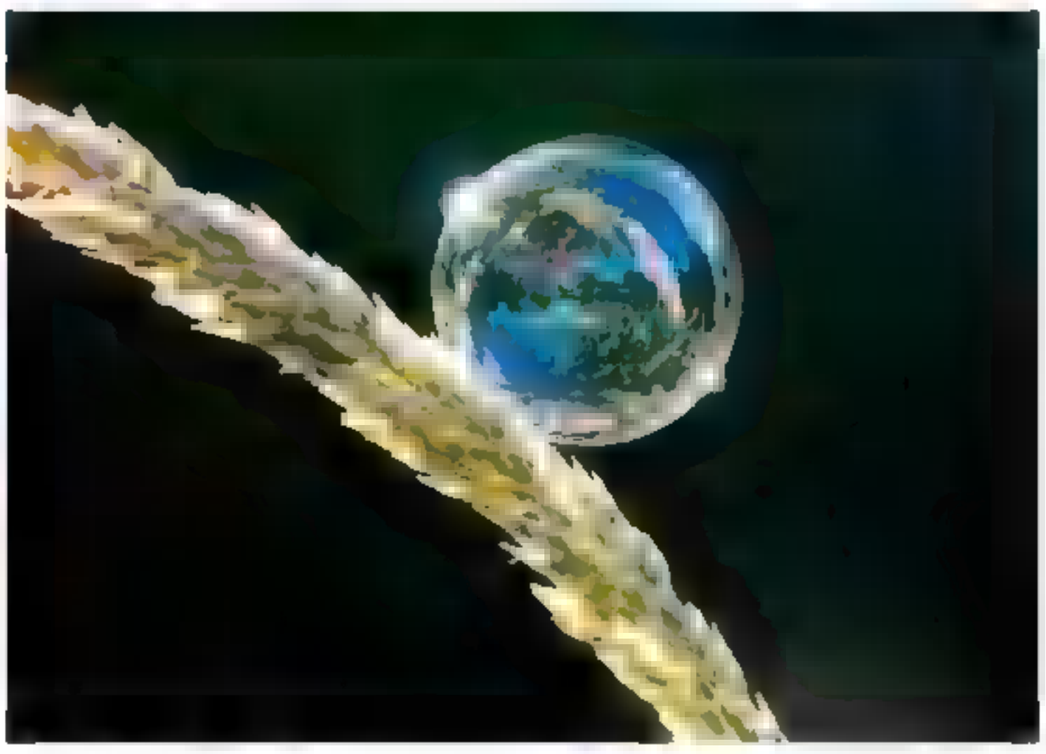
Parks These pictures were chosen from reader photos posted to the Your Shot website. Continue the conversation with our editors—and with NATIONAL GEOGRAPHIC readers—by submitting your own images on the theme of "Something New." Photos selected will be published in the January 2007 issue. For guidelines, a submission form, and more information, go to *ngm.com/yourshot*.

Stephen Wolfe Falls Church, Virginia

"The sun had retired," says Stephen Wolfe, who snapped this tranquil scene along the Potomac River. "I'd literally put my camera into its bag when I looked out one last time and saw a heron."

Rolando Nañez Austin, Texas

"The dunes may look like snow," says Rolando Nañez, who captured this image of his family during a trip to New Mexico's White Sands National Monument. "But it was 101 degrees that day."



Winston Rockwell Kirkland, Washington

Though he'd come to photograph birds at a local park, Winston Rockwell found his shot amid a trailing cloud of bubbles blown by another visitor. This one landed on a stem of grass, then burst.

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Body markings on the spicebush swallowtail caterpillar resemble big eyes—and help scare off predators.

Darlyne Murawski's first GEOGRAPHIC story—on passion vine butterflies—was published in December 1993. She is currently working on a children's book about caterpillars.

Thinking Small Most people's travel photographs look a little different than mine: This one reminds me of a visit I made to Cape Cod. Every day I walked past this spicebush swallowtail caterpillar. It hid inside a rolled-up sassafras leaf; it was just a little green thing at first. One day I saw it had turned bright yellow, ■ sign that it was ready to pupate. I had to get a picture of that.

So don't invite me to go on a vigorous hike through the woods. I won't be ■ fun companion since I'm seldom in ■ hurry to get anywhere. I have to poke around, turning over logs, scanning leaf litter, and examining broken branches and buds for insects, spiders, and other small creatures to emerge from their hiding places. For me, it's like ■ hunt for living treasure.

If they're shedding an exoskeleton or laying eggs, that's even better. So much of life's drama happens on ■ very small scale. Since I never know what I might run into, I love to have camera gear handy so that I don't miss the good stuff.

I've found that this habit of close observation works for all habitats: in tide pools, in the garden out back, even in an overlooked basement corner. Evening is often the best time to go hunting because so many animals emerge after dark. When I'm traveling, I can seldom resist ■ nighttime search with a flashlight in hand.

My patience is always rewarded.

Web Exclusive See more of Murawski's work at **ngm.com/0108/feature2**.

Io, comandante del tempo.

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Acier Poli

PANERAI

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Pike National Forest, Colorado A constellation of blazes dots Grouse Mountain. The fire, which scorched more than 2,300 acres in ■ week in April, was the first major forest fire of Colorado's 2002 season, the state's worst on record.

PHOTO: THOMAS COOPER, LIGHTBOX IMAGES

Tehran, Iran A target labels the building where students train with firearms at the Kowsar Female Police Academy. Female police officers in Iran deal mostly with crimes involving women.

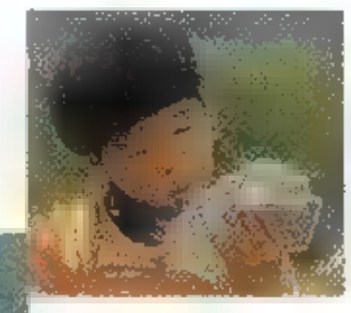
PHOTO: ALEXANDRA BOULAT, VII

South Georgia Island An elephant seal relaxes in a shallow pool along the shores of Stromness Bay, 1,100 miles east of Tierra del Fuego in the South Atlantic Ocean.

Decorate your desktop with Visions of Earth images in Fun Stuff at **ngm.com/0610.**

PHOTO: PAUL SOUDERS, AURORA

VIEWPOINT: *childhood*



"No matter where I am, I immediately connect with children—you never need a translator with kids. They all love to play, although in many cultures they work hard to help earn a living for their families. But whether they're cleaning shrimp with their mothers in Bombay or playing baseball in Hawaii, family love is, at heart, the same everywhere. No one loves their kids more in one country than another. It's universal."

—Catherine Karnow

CATHERINE KARNOW NATIONAL GEOGRAPHIC PHOTOJOURNALIST

Issued by HSBC Holdings plc.

An age of innocence? Or do the opinions and habits you formed then still shape you now?

We all have our own memories of childhood so we're all entitled to be experts on the subject.

At HSBC, we talk to over 125 million customers all over the world. And we've learned to value one thing taught to us by children – the joy of an open mind.

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A Viking's Grim Grin Cosmetic dentistry seems to have been in fashion among Vikings who lived a millennium ago. Examining 22 skulls of Viking men from four cemeteries in Sweden, Caroline Arcini of Sweden's National Heritage Board discovered that they filed furrows across their upper front teeth (above), perhaps with stone or iron tools. The consistency of the marks and their location seem to rule out injury or use of the teeth as tools, as seen among the Inuit, who soften sinews by drawing them across their teeth. More likely, the marks denoted a person's trade or were badges of honor for warriors, and may have been colored with fat and charcoal for better visibility. Dental modification, practiced in cultures around the world, had never before been seen in Europe. *—Michael Klesius*

Fresh Dirt

Warm water—not too hot, not too cold—flowed through this bronze tap 1,800 years ago. Discovered in the remains of a small villa in what is now the Dutch town of Hoogeloon, it is the oldest faucet found in the region that could release a temperate mixture of hot and cold water.

Archaeologist Peter Schut of the Dutch National Service for Archaeological Heritage, who first noticed the faucet's advanced technology, says the tap was recovered near vestiges of the villa's bath. A fire-fed boiler in a room next to the bath heated the hot water, which, along with cold water from another tank, flowed through pipes to the faucet.

In Rome and southern Italy, complex waterworks, including systems to regulate water temperature, had been in use since the first century A.D. Schut suggests that the person who owned this tap was a tribesman from the Roman province of lower Germania who served in the Roman army and returned to the land of his birth after retirement. There he built a fine farmhouse, outfitting it with fancy plumbing. Isotope analysis reveals that the tap was made locally.

PHOTOS: STAFFAN HYLL (TOP); TON PENDERS, NOORDBRABANTS MUSEUM

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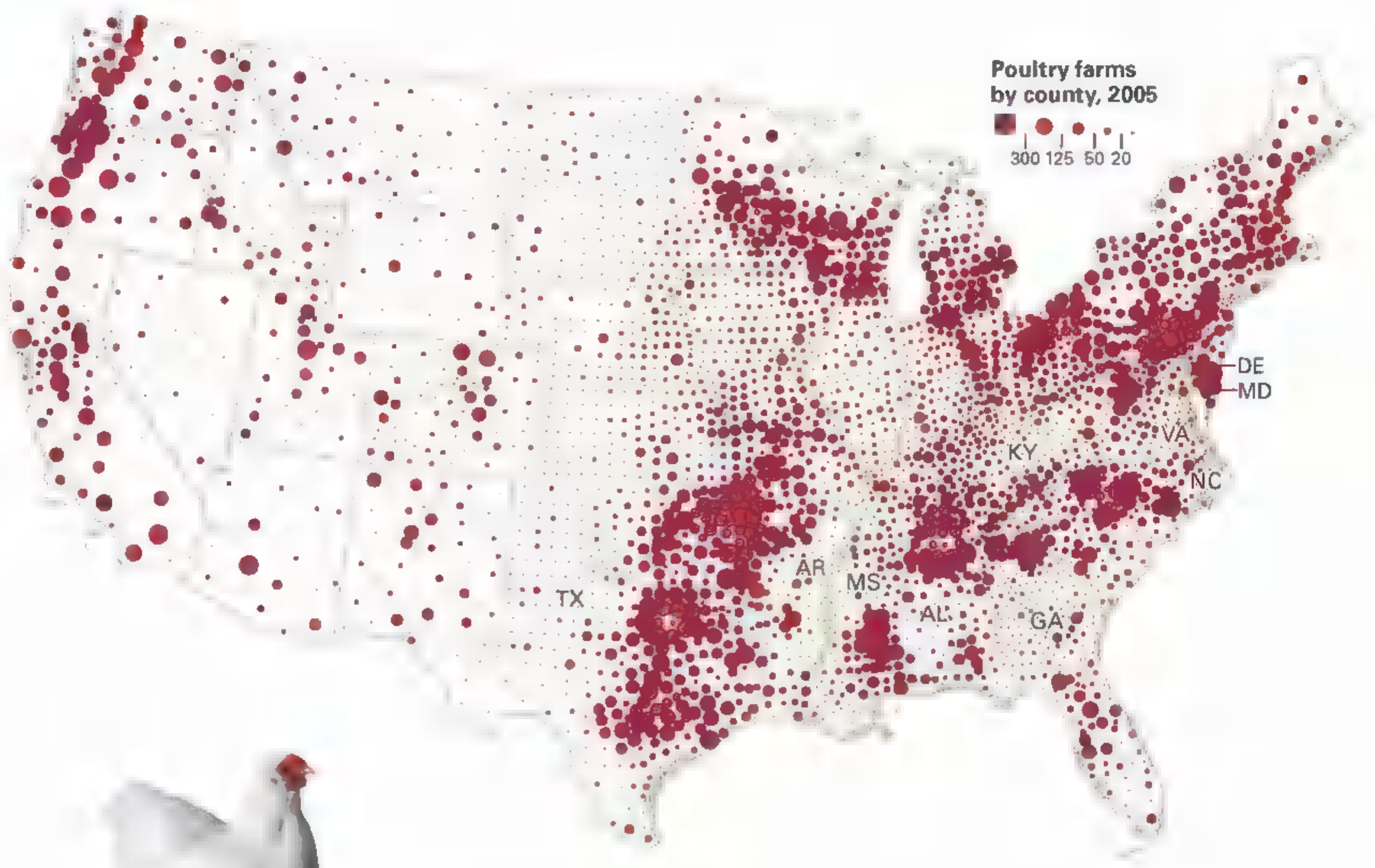


TOP POULTRY PRODUCERS
Total number of chickens and turkeys, 2005

Georgia	1	1.34 billion
Arkansas	2	1.26 billion
Alabama	3	1.07 billion
Mississippi	4	860 million
North Carolina	5	782 million
Texas	6	646 million
Kentucky	7	303 million
Virginia	8	284 million
Delaware	9	282 million
Maryland	10	260 million

Keeping Bird Flu Off the Menu

Bird flu's been here before. The last major outbreak hit Pennsylvania poultry farms in 1983. And though that strain of the virus never threatened human lives, it resulted in the destruction of 17 million birds at a cost of 60 million dollars.

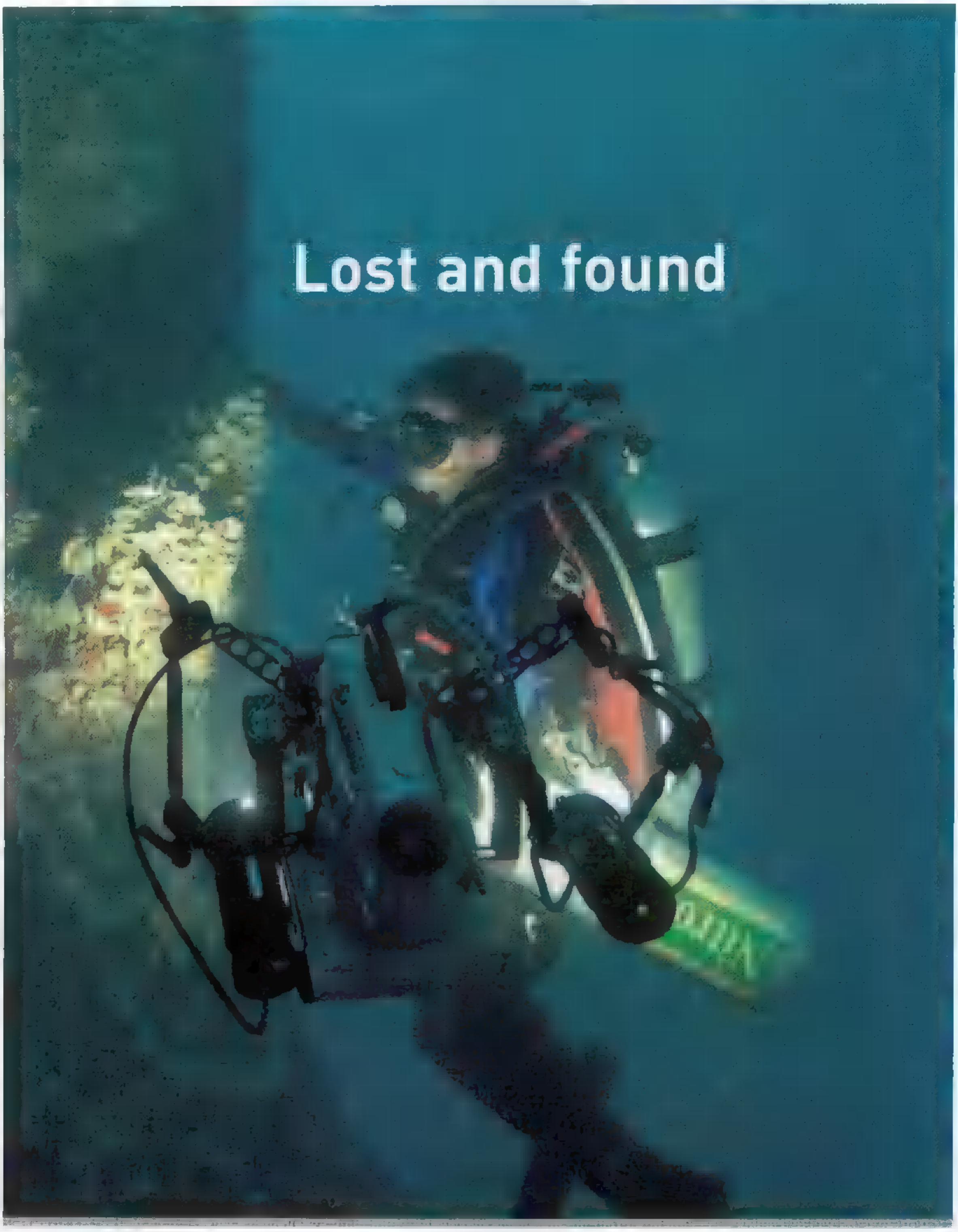
Now, as the new H5N1 virus, which is deadly to humans as well as to birds, menaces Asia, Europe, and Africa, the stakes in the United States are even higher. U.S. poultry farms last year produced almost nine billion broilers (chickens raised for meat), a quarter of a billion turkeys, and 90 billion eggs, all worth nearly 30 billion dollars.

Just as important as protecting chickens, turkeys, and ducks from the killer flu is calming public jitters about its possible emergence in the human population. Earlier this year in Italy, for example, poultry sales plunged 70 percent even though H5N1 had appeared only in wild birds.

Thanks to strict security practices in the U.S. and the isolation of domestic stock from wild birds and other livestock, "the risk of an H5N1 outbreak is low," says poultry expert Carol Cardona. "But this is not a virus we want to mess around with." *—Michael Klesius*

Multimedia Hear more about this deadly disease and why scientists fear a global pandemic at **ngm.com/0510.**

NGM MAPS. SOURCE: NATIONAL AGRICULTURAL STATISTICS SERVICE, USDA. PHOTO: ROBERT DOWLING, CORBIS

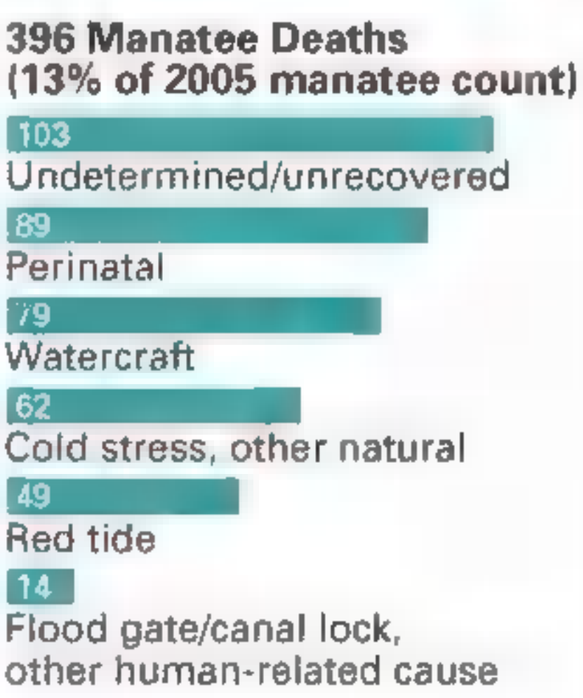


THE SEA HUNTERS, CHECK LOCAL LISTINGS

The new series of Sea Hunters recounts the stories of seven amazing voyages to reveal the fascinating history behind some of the world's long-lost underwater shipwrecks.

ENVIRONMENT

Swimming Into Oblivion Manatees should be thriving. The docile creatures, which weigh up to a thousand pounds, have no natural predators. But these icons of Florida's waterways suffered their second deadliest year on record in 2005, with 79 killed by boats and many more deaths suspected. Although Florida has long restricted watercraft in manatee zones, boats have killed some 1,400 animals over the past 30 years and maimed scores more. Females bear only one calf every few years, and the calves mature slowly, making it difficult for the population to outpace the modern world's lethal hazards. Perhaps as few as 3,100 of the animals survive. Manatees will likely make it into the next century, but they face increasingly grim odds. *—Cate Lineberry*



What's New?

Polystyrene, the petroleum-based plastic popular for use in disposable drinking cups, is rarely recycled and doesn't decompose. But scientists recently found a way to convert the stuff into something more ecologically friendly. After melting polystyrene into styrene oil, they feed it to a bacterium called *Pseudomonas putida* that is commonly found in soil. The resulting output from the bacteria is biodegradable plastic.

A greased-lightning commute can be had in Valencia, Spain. Used cooking oil flows through the engines of about a hundred of the city's public buses. Vegetable oil collectors retrieve the fry grease from restaurants and hotels around town and bring the slippery goo to a processing center where impurities are filtered out. The processed cooking oil is then mixed with petroleum diesel and other biodiesels to create fuel for the buses. Other European cities are now looking into adopting similar programs.

PHOTO: FRED BAVENDAM, MINDEN PICTURES. GRAPHIC: NGM MAPS; DATA FROM FISH AND WILDLIFE RESEARCH INSTITUTE, FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

Malaysian Ringgit

Some countries choose to represent their histories on their banknotes; Malaysia opts for its future. In 1996 the Malaysian central bank unveiled a new currency with the theme *Wawasan*, or Vision, 2020, a nationwide initiative to make Malaysia a fully developed country by the year 2020. Equipped with state-of-the-art security features hidden in its design, the ringgit emphasizes modern symbols, such as transportation and communications (below), on its six denominations.

Malaysia's light-rail transit streaks into the future. Layered ink is used for security.

Micro-lettering near the Malaysia Airlines aircraft is only visible with magnification.

Security threads that change color in ultraviolet light pass through an image of a commercial vessel.

Malaysia's first king appears on the front of every bill and in a security watermark in this area (above).

A high-rise tower and satellite represent Malaysia's emerging telecommunications network.

A map of Southeast Asia, under ultraviolet light, will appear fluorescent and change color.

Malaysia's central bank's logo features a *kijang,* or deer, which is also on its gold coins.

Security fibers scattered in this area show up red, yellow, and blue in ultraviolet light.

PHOTOS: REBECCA HALE, NGS STAFF

New Lemurs Scientists have discovered two new lemur species on Madagascar. *Mirza zaza*, a giant mouse lemur, was found on the island using traditional methods: "a lot of frustrating trap setting and tree climbing," explains researcher Peter Kappeler of the University of Göttingen in Germany. But the other new lemur (left) was discovered in an unexpected place—on the Internet. While comparing genome sequences of *Mirza zaza* with other lemurs on an online database, researchers noticed one with a 3.8 percent genetic divergence. Kappeler and his colleagues located the lemur in question at a Zürich zoo, where further analysis identified it as a new species, which they named *Microcebus lehilahytsara.* Kappeler says, "Discovering yet another species of lemur underlines the importance of conserving Madagascar's flora and fauna." *—Whitney Dangerfield*

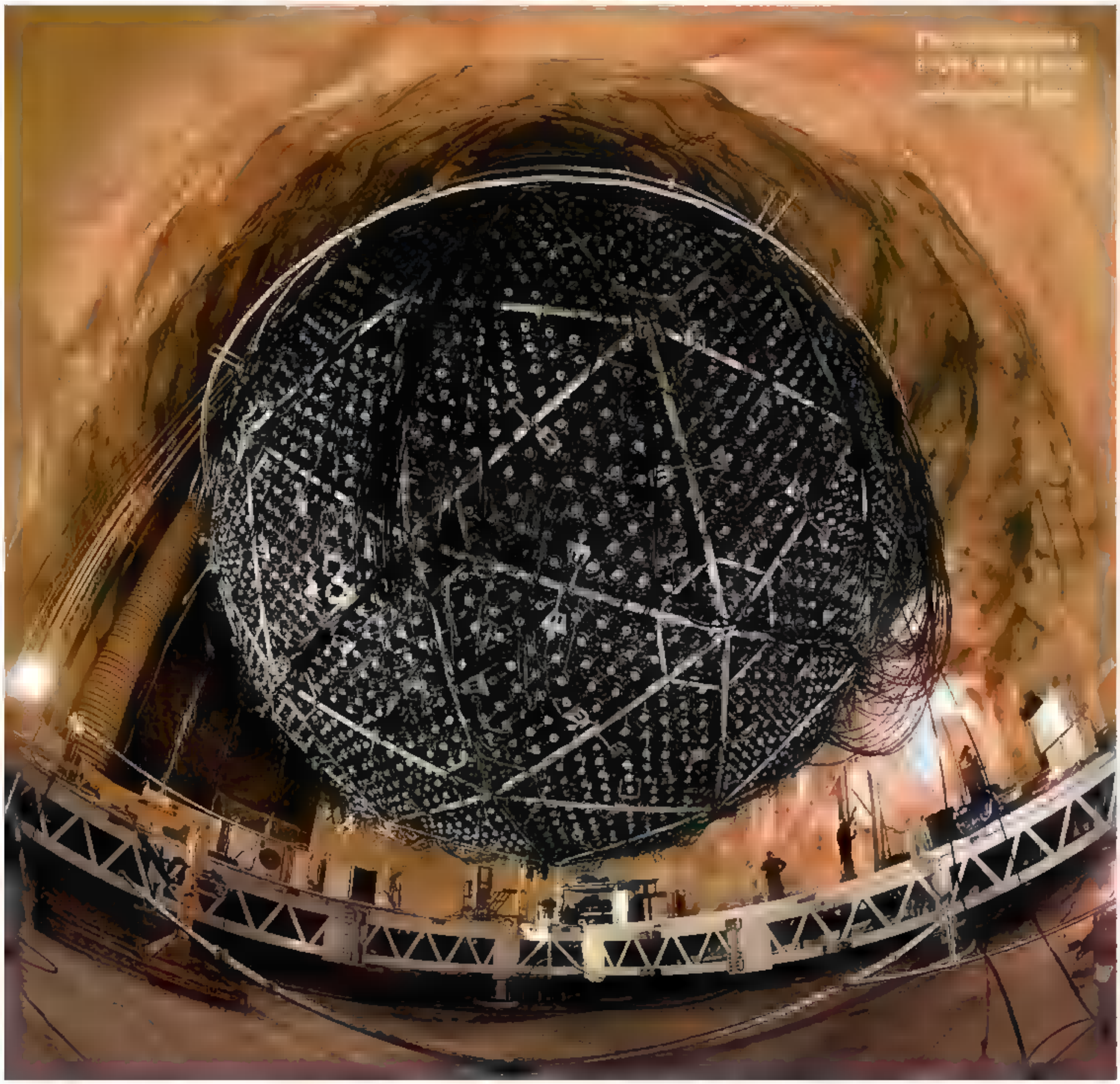
Animal Watch

Lefty marine snails have the advantage over crab predators. Most marine snail shells develop in a spiral that curls to the right. But a small number, less than one percent, develop left-handed, or sinistral, housings. The crab *Calappa flammea*, which preys on whelks and cone-shell snails, has ▮ "tooth" on its right claw for peeling snail shells. A recent study indicates that these crabs have a hard time opening the sinistral snails and often just leave them alone. Despite this apparent advantage, marine snails haven't evolved toward having mostly left-handed shells; scientists are at a loss to explain why.

The Roti Island snake-necked turtle was first described as a new species in 1994, but the recognition has proved disastrous for the saucer-size creature with a long, ropy neck. Demand among hobbyists in Japan and the West soared. Now illegal trade of the turtles, which exist in the wild only in the wetlands of Indonesia's Roti Island, has pushed the species to the edge of extinction.

To count elephants, researchers spend days in the field and sometimes must rely on the imperfect science of tallying the animals' dung balls. But geophones, devices ordinarily used to record seismic activity, also might be able to do the job. A geophone buried in Namibia by ▮ team of geophysicists recorded the footfalls of large animals up to 300 feet away. Scientists could differentiate the steps of elephants from other animals 82 percent of the time and are tweaking the technique to improve accuracy.

PHOTO: ROBERT ZINGG, ZOO ZÜRICH



Neutrino Observatory Every second, the sun releases 200 trillion trillion trillion tiny particles called neutrinos that pass virtually undetected through Earth and everything on it. The particles can reveal information about the sun, the nature of dark matter, and the large-scale structure of the universe, but first they must be captured. Scientists do this at the Sudbury Neutrino Observatory, 6,800 feet beneath Ontario, Canada. In a mine cavity the size of a ten-story building (diagram, left), a tank holds 1,100 tons of heavy water, which contains more neutrons than ordinary water. About 20 times a day, a passing neutrino crashes into a neutron in this dark sphere and creates a faint flash. A network of 9,600 photomultipliers that coat the vessel (above) detects the flash, which is then analyzed for data about the neutrino that caused it. The detector's location deep within the Earth shields it from high-energy cosmic rays from space that would interfere with observations of these tiny collisions. *—Michael Klesius*

PHOTO: ROY KALTSCHMIDT, LAWRENCE BERKELEY NATIONAL LAB. ART: DON FOLEY

George Schaller watches snow falling in an Afghan shepherd's yurt in 2004. He has spent much of his life in the field, studying animals and hoping to preserve the wild places where they live.

George Schaller
Parks: Where the Spirit Soars

INTERVIEW BY JOHN G. MITCHELL

At 73, George Schaller is one of the world's preeminent field biologists. He has just returned from two weeks in Iran, monitoring the fate of the last of the Asian cheetahs, when we meet at his home in the wooded hills of western Connecticut. In a couple of weeks, he'll be off to the remote edge of Alaska to retrace a trek he took half a century ago. In addition to making his expeditions, he serves as vice president for science and exploration at the Bronx-based Wildlife Conservation Society. Over the decades, the modest, soft-spoken Schaller has been a force in helping establish wildlife sanctuaries and reserves throughout the world—though he is quick to say that he is "only one of many" trying to save natural lands. Born in Berlin, Schaller immigrated with his family to the United States in 1947. He is the author of 15 books, including The Serengeti Lion, *which won a National Book Award in 1973, and hundreds of articles and papers published over the course of his 54 years afield. A small, spare cabin, separate from the comfortable house he shares with his wife, Kay, serves as his office. There is no computer or telephone here (electronic devices are confined to the house). This, he says, is a place for contemplation.*

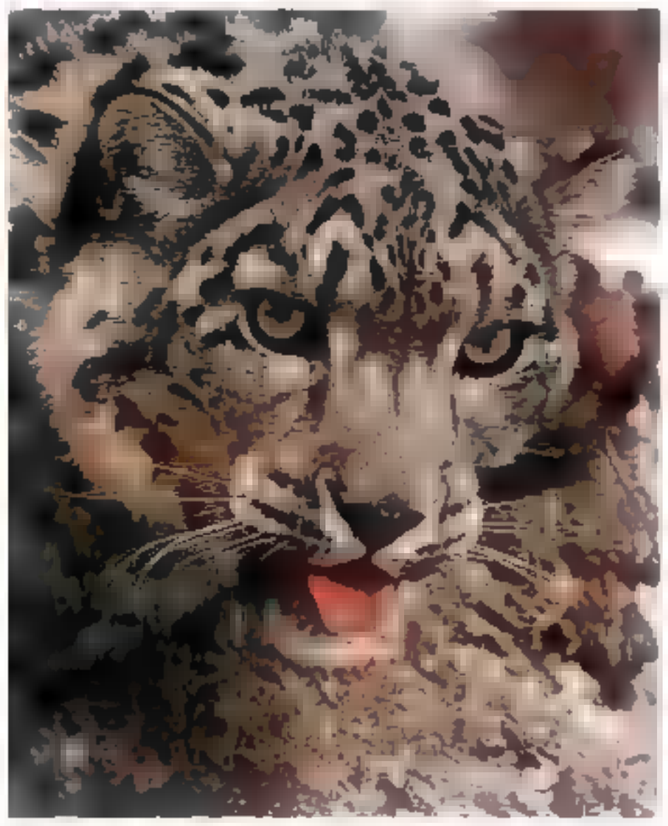
When did you first become interested in the natural world?

As a kid, I collected lizards and snakes and kept opossums, and I liked to roam around the woods watching birds. But it wasn't until I got to the University of Alaska in the early 1950s that I discovered how a boyhood pastime could actually become a legitimate adult profession. So what I'm basically doing now is continuing what I have done as far back as I can remember.

What were your studies at the University of Alaska?

I started in wildlife management and found out that wildlife management meant raising animals for hunters to shoot, which was not my interest. Later, I drifted into straight field biology, and I stuck with that because it's so satisfying. I was very, very lucky that the New York Zoological Society, now called the Wildlife Conservation Society, took me on staff in 1966. They sponsored my gorilla work in Africa, and over the years they have provided the perfect home base for me. I have the freedom to determine

PHOTO: BETH WALD



Schaller, who took the first photograph of the endangered snow leopard in the wild, famously wrote, "When the last snow leopard has stalked among the crags . . . ■ spark of life will have gone, turning the mountains into stones of silence."

what I think is important in research and conservation. The Wildlife Conservation Society has a kind of vision that stimulates you and continually pulls you toward conservation goals.

You've been credited with having helped establish several of the world's greatest reserves, including ones in the Amazon Basin, the Gobi desert, Myanmar, and Tibet. How cooperative have you found most governments in your efforts to set aside reserves?

Let us first be very clear. As a foreign guest in a country, you don't establish anything. Establishment is up to the government, and all one can do, and all I do, is collect information on the wildlife and the distribution of people and make suggestions. If they are reasonable suggestions, I have found most countries very willing to listen. In fact, it is one of the pleasures of working in other countries, especially ones not overrun with NGOs [nongovernmental organizations], that government officials do listen, and they appreciate your efforts. If it is feasible and makes sense within their system, they will move ahead and do something. For example, the Chinese government has done tremendous work over the past 15 years or so in Tibet. Relatively pristine land, with few people living on it, is still available there for refuges, and now one-third of Tibet is officially under some sort of reserve status. For some reason, the Chinese government doesn't advertise this kind of thing, but the Chang Tang Reserve is about 120,000 square miles, and the government is working to protect other tracts. The end result could be as much as a quarter million square miles of reserves.

Why do we need parks and reserves?

It's essential that each country keep part of its natural heritage untouched, as a record for the future, a baseline to measure change, so people can see the splendor of their past, before the land was degraded. And if we ever want to rehabilitate habitat, we need to see how things used to be. These parks and reserves, these untouched places are also genetic reservoirs, where plants and animals that don't exist elsewhere still survive. They can be invaluable to the human species as sources of food or medicine. If we destroy the parks, they're gone forever, and we may be losing something invaluable to us.

In what other large areas has your work helped galvanize government action?

The Pamirs in Pakistan. I surveyed them in 1974 and wrote a report, which through friends I got to the prime minister. I had suggestions for a reserve, and he said they'd establish it. Then across the border, again with a little bit of urging from me, China established another reserve. At that time, in the 1980s and '90s, Tajikistan and Afghanistan weren't open to an American wandering around. Now it's no problem, so in the past few years I've

PHOTO: GEORGE B. SCHALLER

It's essential that each country keep part of its natural heritage untouched, as a record for the future, a baseline to measure change, so people can see the splendor of their past, before the land was degraded. If we destroy the parks, they're gone forever.

been working there, and we're getting the four countries together to try to set up a big transfrontier reserve.

Tell us about Iran. The government there is interested in trying to hang onto the few surviving Asian cheetahs?

They are very interested. I've been going there since the year 2000, and the government is very supportive. There are only 50 or 60 Asian cheetahs left. Iran has lost its tigers and lions, so you can understand why it doesn't want to lose the cheetahs, too.

You were just over there during two very tense weeks, politically, between the United States and Iran. That didn't interfere with your work?

Oh, no. It has nothing to do with the Iranian people. They're tremendously friendly. It's a joy to be in a country like that, with its wonderful culture and its willingness to do something to save its wildlife.

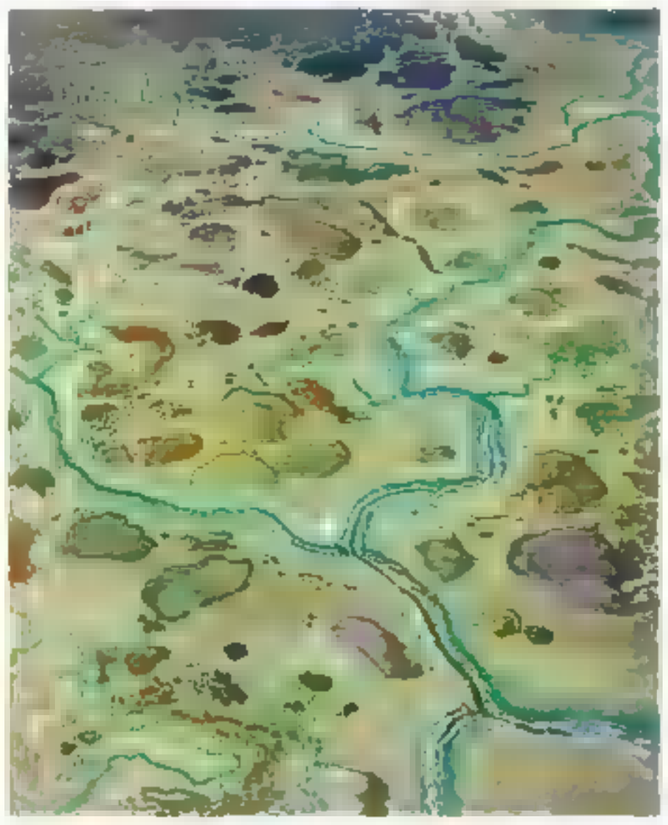
We keep hearing about "charismatic megafauna"—elephants, lions, tigers, grizzlies, giant pandas, and other big animals that capture the public's interest. Has that term become a cliché? Does it adequately describe the animals you've been studying?

I enjoy watching big, beautiful, interesting animals. But you can't just sit around watching them. You have the moral obligation to help protect them. The advantage of studying these animals is that they draw attention. It's easier to get money to study a panda than it is to study a leech. Now that doesn't mean that the panda is necessarily more important biologically than the leech. It simply means that when you get the funds to study and protect a big, beautiful animal, you automatically protect the leeches and ants and all the other species in the area. We're always talking about biodiversity, but that's an abstract term. We're not saving the panda because of biodiversity. We're saving it because it arouses our emotion. And the emotional component is extraordinarily important to get the public behind conservation.

You were among the first to study the mountain gorilla, and you reported that, instead of being a brute that wanted to tear you apart, it was in fact a very intelligent, gentle creature. You wrote, "No one who looks into a gorilla's eyes can remain unchanged. . . . We know that the gorilla still lives within us." What do you recall of the first time you looked into a gorilla's eyes?

The first time was so close. I was entranced and apprehensive, because gorillas, like most large animals, are individuals, and I did not know how she would respond. Some are temperamental, some are very placid. But her eyes were kind, and as with all gorillas when they are somewhat apprehensive and are trying to avoid prolonged eye contact, she slowly turned her head from side to side.

The wonderful thing about gorillas is that they have given Rwanda



One of the most pristine places left in the U.S., Alaska's Arctic National Wildlife Refuge was set aside in 1960, after a Schaller report helped highlight its biological diversity. Today, the refuge's coastal plain is under consideration for oil drilling.

an identity. Here you have this extremely poor, overcrowded country, yet in spite of its history of civil war and genocide, the government has said we must protect and save the gorillas. And the government is doing that. I think that is an absolutely tremendous thing for a country like that to do.

How do you deal with local people who may live on the fringes of protected areas and want access to the area for subsistence?

Obviously, there are certain areas where human activity should not be allowed—ever. Because, yes, you can say there are only a few people now, but in 20 years there will be twice as many, and pretty soon the whole area could become degraded. But we should try to find ways to help local people have reasonable access to some resources. At one park in Nepal, outside companies were putting up little hotels and making all the money, and the locals didn't benefit. So a number of communities got together and decided to turn their fields back into high grass and brush. Then rhinos, tigers, and other animals started to come out of the park into those old fields, and the local people themselves were able to cater to the tourists. They made far more money than they would have from continuing to farm the fields. But that's a rare exception. Ecotourism generally sounds like such ■ good idea. Everybody talks about it, but when you look at the statistics, often only a small percent of the money spent by tourists goes to the local people. Because it's the outside tour companies, outside hotel owners, outside porters who are making most of the money. Unless tourism is set up specifically to benefit the local people—as in the Nepal example—the locals are not going to get much out of it.

In a few weeks, you'll be off to Alaska to retrace part of the trek you did half ■ century ago with conservationists Olaus and Mardy Murie, when the drumbeat started to establish the Arctic National Wildlife Refuge. What are your memories of that adventure?

It was 1956, a wonderful summer. We spent most of it on the south slope of the Brooks Range. Apart from our scientific studies, the Muries emphasized what Olaus called the "precious intangible values." That had a great impact on me, because here was a well-known biologist in his late 60s who began each day with a sense of adventure, a sense of joy and curiosity. I remember walking across the tundra with him. He came upon a soggy pile of bear droppings, cupped it in his hands, and poked through it to see what the bear had been eating. To me, at the time, that was impressive. As for helping to establish the Arctic refuge, I did little except write a few letters. The refuge was basically set up by Alaskans. One person who did do a tremendous amount to have it set aside is now the senior senator from Alaska, Ted Stevens. He worked in the Department of the Interior at the time. Maybe that's something he'd prefer to

PHOTO: GAVRIEL JECAN, CORBIS

It is tremendously worrisome that we don't talk about nature anymore. We talk about natural resources as if everything had a price tag.

forget. Anyway, the refuge was established in 1960, and then President Carter enlarged it under the Alaska Lands Act.

And now the Bush Administration and Senator Stevens are looking for a go-ahead to drill for oil on the refuge's coastal plain. How do you feel about that?

It's a warning that you can never give up if you really treasure something. Nothing is safe. About 95 percent of Alaska's North Slope has already been opened for oil leases. Can't we save the rest? What kind of people are we if we don't? There are leased fields on the North Slope that haven't even been drilled yet. But now the oil companies are trying to get into the refuge, because if they can get in there, they can get in anywhere.

Where do you think we're heading with global warming?

You can argue endlessly over how much is natural climate change and how much is caused by humans. But the fact is, climate is changing very rapidly, and the scientific consensus is that much of it is caused by people burning fossil fuels. If you raised the fuel efficiency of cars to 40 miles per gallon, which is perfectly feasible, and you eliminated the special deals for SUVs, each year you would save ten times as much oil as the Arctic National Wildlife Refuge would likely produce. This is what's very peculiar. We are supposed to have an educated public, but where is it? Our schools and universities have failed to instill an environmental awareness. Conservationists have also failed. All you hear from some of them these days is talk of "sustainable development."

Do you have a problem with the idea of sustainable development—finding ways to use but not deplete natural resources in national parks and reserves?

There are certain natural treasures in each country that should be *treated* as treasures, and it is up to conservation organizations to fight on behalf of the special places. Too many of these organizations have lost sight of their purpose. Their purpose is not to alleviate poverty or help sustainable development. Their purpose must be to save natural treasures. What are we going to do? Invite the homeless to move into the Metropolitan Museum of Art, or the Taj Mahal? Those are cultural treasures. It's the same with the Serengeti, the Arctic National Wildlife Refuge, the Virunga volcanoes with their mountain gorillas. I've heard some conservation organizations argue that local people should have the right to manage those reserves and use them as they please. Well, I consider that utter nonsense. It is tremendously worrisome that we don't talk about nature anymore. We talk about natural resources as if everything had a price tag. You can't buy spiritual values at a shopping mall. The things that uplift the spirit—an old-growth forest, a clear river, the flight of a golden eagle, the howl of a wolf, space and quiet without motors—are intangibles. Those are the values that people do look for and that everyone needs. □

THE FUTURE OF PARKS

Hallowed

Nothing Is Ever Safe

Landscape and memory combine to tell us certain places are special, sanctified by their extraordinary natural merits and by social consensus. We call those places parks, and we take them for granted. Some are large, spectacular, and wild—such as Yellowstone and Kruger. Some are intimately local—such as Buttes-Chaumont, set within a busy neighborhood of Paris. Many are threatened by pressures from the societies that surround them, even as our hunger for the respite they provide grows ever greater.

We dedicate the bulk of this issue to Earth's most cherished natural places. David Quammen surveys the debate on a theme roughly formulated as "parks versus people." John G. Mitchell traces the history of the parks idea in one country, the United States, and assesses the perils faced by America's National Park System. Jennifer Ackerman considers the role of parks in urban environments.

In his 1995 book *Landscape and Memory,* social historian Simon Schama wrote: "All our landscapes, from the city park to the mountain hike, are imprinted with our tenacious, inescapable obsessions." Human obsessions aren't always pretty. But these chosen landscapes—parks, of every sort—may show us at our best. —*The Editor*

Ground

EAST HAMPTON LIBRARY, LONG ISLAND COLLECTION

Serra dos Órgãos National Park, Brazil

FRANS LANTING

Namib-Naukluft Park, Namibia

OLIVIER GRUNEWALD

Great Barrier Reef Marine Park, Australia

THEO ALLOFS

Auckland Islands National Nature Reserve, New Zealand

KEVIN SCHAFER

Galápagos National Park, Ecuador

TUI DE ROY, MINDEN PICTURES

Serengeti National Park, Tanzania

MITSUAKI IWAGO, MINDEN PICTURES

Grand Teton National Park, United States

HENRY H. HOLDSWORTH, WILD BY NATURE GALLERY

Bryce Canyon and Yellowstone National Parks, United States

RALPH LEE HOPKINS, LONELY PLANET IMAGES (OPPOSITE); JEFF VANUGA, NATURE PICTURE LIBRARY

An Endangered

A national park is, in more cases than not, a wildly ambivalent act of collective purpose: dreamy yet provident, selfish yet sacrificial, local yet global in significance. Unlike a national anthem or a national flag, a national park exists in the concrete dimensions of geography, biology, and economics—and in the dimension of symbolism as well. It has living denizens and physical boundaries. It has benefits and costs. It has friends, and sometimes it has enemies. It has an aura of sacred permanence as a place that society has chosen to set aside and protect forevermore.

But how long is forevermore?

Within the past two decades, there has been a sort of backlash against the very idea of national parks—or at least, against that idea in its most rigid, presumptuous form. Simplistically stated, the theme is "parks versus people." The essence of the critique is that conservation goals can't be met merely by circumscribing parcels of landscape, calling them parks, and evicting or excluding the needy humans who want to scratch out a living there. And that much is certainly true. To approach conservation purely by lockout is politically infeasible on a planet with six and a half billion humans; equally important, it's inhumane and unjust. The benefits are enjoyed mainly by distant, affluent members of society, while the costs are paid mainly by struggling, powerless folk on the landscapes nearby. "Save the animals, keep the people away" is a strategy that won't work and shouldn't. Human pressures and needs will inevitably prevail, swamping each unpopular, undemocratic park like an ark with low gunwales. Take that argument to its extreme, though, and you have this: Protecting landscape and biological diversity by creating national parks is only another elitist form of cultural imperialism.

The opposing view, also in its most extreme form, is that parks must be parks, protection must be protective, and if chain-link fencing and armed wardens are necessary, so be it.

Neither of these views is entirely wrong or entirely right. But reconciling them hasn't proved easy. "The discourse on parks is being driven toward brittleness," according to one concerned commentary, published recently in the journal *Conservation Biology,* by Kent H. Redford of the Wildlife Conservation Society and two colleagues. Their sensible essay is titled "Parks as Shibboleths"—a shibboleth being, in case you've forgotten your

Idea

Old Testament vocabulary, a sort of password that signals loyalty to some group or fixed idea. The very word "park," say Redford and his co-authors, has become a "coarsely textured term increasingly devoid of meaning," used now by conservationists and social advocates mainly to whomp each other upside the head. That sort of brittle discourse, the essay points out, is "bad news for both protected areas and people living in and near them."

Rock art in Australia's Kakadu National Park—managed jointly by the government and Aboriginal groups.

And now it's going beyond discourse. In May 2005, over a hundred armed people seized a research-and-management camp in Guatemala's Laguna del Tigre National Park, demanding acquiescence to their status as settlers within the park and, after some palaver, taking four hostages. Their demands were eventually met, by the state governor, with promises of material help in exchange for release of the hostages. Four months later, in Kenya, the minister of wildlife and tourism announced that Amboseli National Park would be downgraded to a national reserve and returned to a governing council of the Maasai people, its original owners. Amboseli, a diverse landscape famed especially for its elephants, is considered one of the jewels of East African conservation. In an open letter to Kenya's president, 29 organizations complained that the downgrading, done without consultation following a published notice in the *Kenya Gazette* (the official legislative journal), was illegal.

This brings us back to the dictionary. There is an English word, less ancient than shibboleth, used in Britain and elsewhere for such disestablishment of a national park: de-gazetting. It's a word with which we should all acquaint ourselves; it's a word, unfortunately, of the future. How so? Because other efforts to de-gazette national parks are likely to arise soon, as we citizens of various countries find our short-term appetites more compelling than our long-term ideals. I alluded to this already, when I mentioned that national parks exist in the dimension of economics as well as geography, biology, and symbolism. To those, add two more: They exist also in the dimensions of politics and of time. What has been done, however noble and farsighted, can be undone.

OF COURSE, NATIONAL PARKS aren't the be-all and end-all of nature conservation. They're just one method, one tool, slightly more conspicuous and complicated than the rest.

GREG ELMS, LONELY PLANET IMAGES

Other forms of landscape protection exist within many countries—the wildlife sanctuary, the hunting preserve, the designated wilderness, the *réserve naturelle intégrale* (in Madagascar), the *zapovednik* (in Russia), and more. One international body, the World Conservation Union, defines five categories of protected areas other than national parks, and those five categories contain more than 60 percent of all such areas on the planet. National parks in the strict sense account for only 22.7 percent of the total expanse.

None of those other forms of protection, though, does or says what a national park does and says. None embodies the idea of a national citizenry standing in special relationship—as enjoyers for the present, as guarantors into the future—of some treasured parcel of the natural world. Only national parks do that. They speak more loudly and more proudly of a country's special gifts, and of its ideals.

Serengeti National Park tells the world that the people of Tanzania, accepting some burden of inconvenience, find themselves privileged to embrace within their boundaries a vast grassland filled with lions—come and see. Galápagos National Park testifies that Ecuadorians are cognizant not just of the extraordinary biological riches (including the marine riches) of the archipelago, but also of its crucial role by way of Charles Darwin in the history of science. Ujung Kulon National Park, at the western tip of Java, codifies Indonesia's commitment to the survival of the sorely endangered Javan rhinoceros. Fiordland National Park reminds us that New Zealand is the Norway of the south.

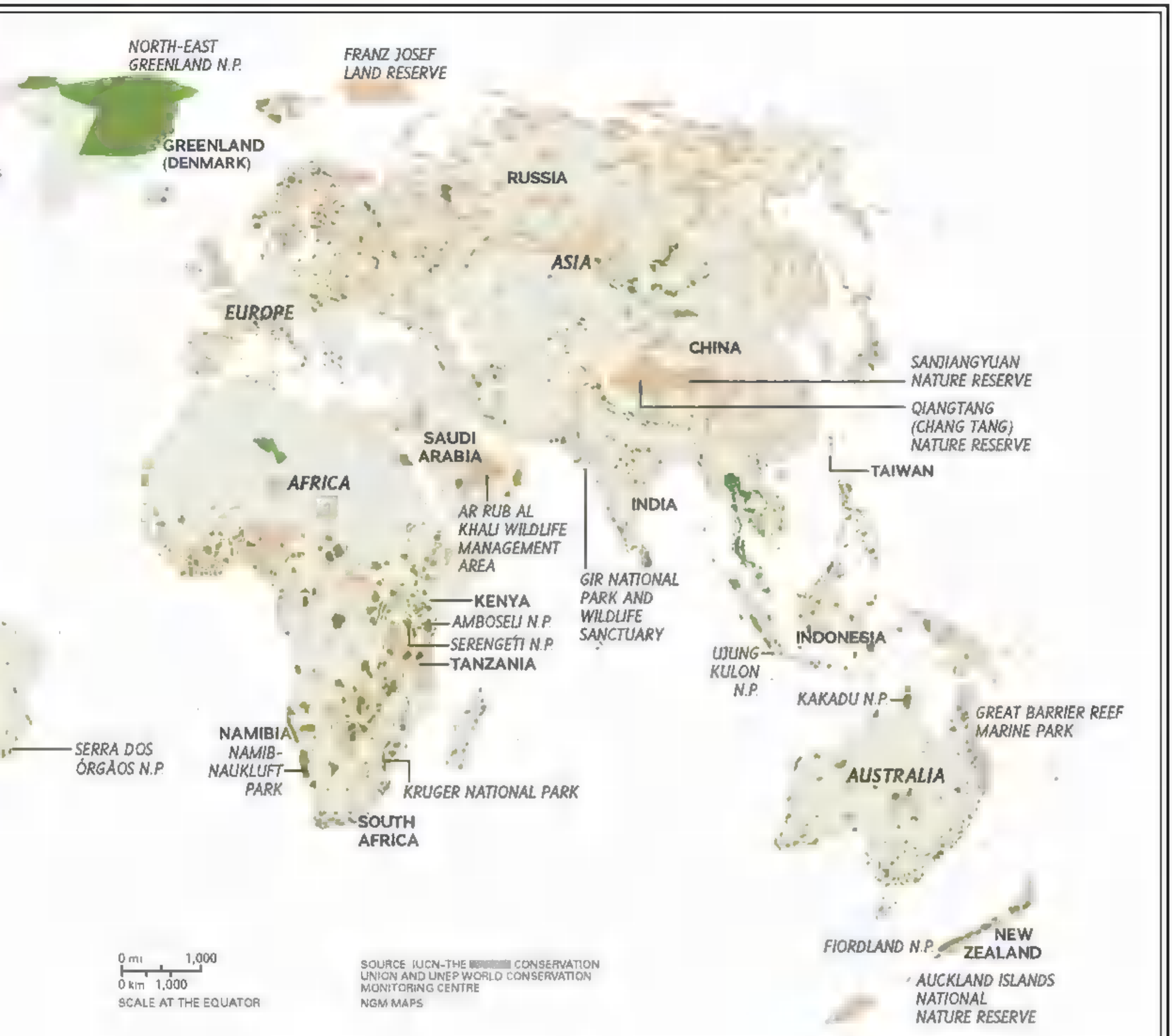
WORLD PROTECTED AREAS

Nearly 12 percent of Earth's land surface is protected as national parks, reserves, or other areas, according to the World Conservation Union.

National park
Other

Not all protected areas are large enough to be shown.
Protected areas shown only where boundary data are available.

Part of what makes national parks complicated is the diversity of their origins and the ways their meanings have changed over time. India's Gir National Park, for example, amid the dry forest and rocky hills southeast of a city called Junagadh in the state of Gujarat, received its current designation only in 1975. It is surrounded by the Gir Wildlife Sanctuary, which was constituted in 1965 and is managed under slightly different regulations, allowing for the continued residence (within the sanctuary doughnut but not the park at its core) of some indigenous livestock-raising people known as Maldharis. Together the park and the sanctuary encompass 545 square miles of habitat for the last remaining wild



population of the Asiatic lion, *Panthera leo persica.* Although foreigners may assume that the tiger is India's signature big cat, in fact the lion still holds an important place within Hindu beliefs, and until recent decades it was considered India's national animal. The lion population at Gir is now strictly protected from hunting and other direct forms of attack. But the park and its buffer zone wouldn't exist today if not for prescient action more than a hundred years ago by a local potentate, the Nawab of Junagadh, for whom the lion was valuable first as a game animal.

Even the nawab could understand, with help from his gamekeepers, that these Gir lions had been hunted too much, driving the population perilously low. So, at the start of the 20th century, he declared a temporary ban on lion shooting, giving the Gir forest protection as a de facto wildlife reserve. His motives were practical: He was proud to have lions within his realm, he liked offering hunts to his fancier guests (such as the British viceroy, Lord Curzon), and he saw that a bit of temporary forbearance was necessary, or else the lions would be gone altogether. The nawab's moratorium eventually became a national resolve that the Asiatic lion should not be allowed to go extinct.

Kruger National Park in South Africa and Kakadu in Australia are other instances where important acts of landscape protection had

WITHIN THE PAST TWO DECADES, THERE HAS BEEN A BACKLASH AGAINST THE IDEA OF NATIONAL PARKS. THE THEME IS "PARKS VERSUS PEOPLE."

their origins in complicated, even objectionable, political realities. Kruger was proclaimed as a national park in 1926, under the white-run government of the time, without much regard for the native African peoples whose ancestral lands were at stake. Today its protected status makes it a huge economic asset for post-colonial, post-apartheid South Africa. Kakadu was established in stages, between 1979 and 1991, reflecting a peculiar three-way arrangement among the traditional Aboriginal owners (who wanted formal title to at least some of their ancestral lands), the government of Australia (seeking a nature reserve in the Northern Territory wetlands), and representatives of the mining industry (who held mineral claims and hoped to exploit them). Kakadu is a splendid place, the world's greatest refuge for crocodiles and cockatoos that happens also to encompass a uranium mine.

Kakadu stands snug against the western border of Arnhem Land, a huge Aboriginal reserve that is one of Earth's most gracefully human-occupied wildernesses. Along with Amboseli and Gir, it testifies to a broad truth: National parks generally aren't large enough to assure the conservation of complete ecosystems, including all the upstream resources and processes, all the migratory birds, and all the native ungulate and predator species, some of which live at low densities and require very large areas to support a viable population. The boundaries of a national park, in virtually all cases, are artificial lines (sometimes curvy, sometimes straight) that do not embrace the complete ecological existence of the plant and animal populations dwelling (or visiting) inside. Those boundaries are merely a statutory membrane through which the park, like a living cell, must be able to breathe.

EVEN THE FIRST and most celebrated of American parks, Yellowstone, suffers that limitation. Its boundaries are mostly rectilinear; its ecosystem is not. Yellowstone National Park comprises 3,472 square miles of forest and grasslands and waters, a box-shaped plot of territory, with sides roughly 54 miles by 63. It is relatively large for a park, but not sufficiently large to sustain the long-term health of a population of grizzly bears (as *Ursus arctos*, the brown bear, is known thereabouts). What would Yellowstone be without the grizzly, its signature species? A sad, scenic travesty of its former reality, and not what Americans want it to be. That's why all scientific and policy discussion of the status of the Yellowstone grizzly—Is it secure or still threatened? Should it be delisted from its Endangered Species Act protections?—is framed not by the boxy borders of the park but within the broader perimeter of what is known as the Greater Yellowstone Ecosystem (GYE), an amoeba-shaped expanse defined by the limits of contiguous forest and other relatively undisturbed landscape. The GYE also includes Grand Teton National Park, portions of six national forests, and other public and private lands, totaling more than 28,000 square miles. The bears use these lands without regard for legal designations or boundaries on a map.

To retain grizzlies within Yellowstone Park, so that your great-grandchildren may have a chance of glimpsing one there—eating

yampah roots and clover in the Hayden Valley or gnawing on a moose carcass along the Lamar River—it will be necessary to protect every possible acre of their current habitat outside the park as well as within it. And even that may not be sufficient.

Then again, saving the grizzly is not a purpose articulated in the founding legislation for Yellowstone, as passed by Congress and signed by Ulysses S. Grant back in the spring of 1872. After delineating the tract in question, the law merely said that it was "dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people," and that anyone who dared to homestead there would be considered a trespasser. The wise heads of the 42nd Congress had no inkling that *Ursus arctos* would one day be preciously rare south of Canada's border, nor that this pleasuring-ground would give its pleasure, in part, by serving as a sanctuary to North America's most fearsome mammal. As with other legislation, including the United States Constitution, it was left for later generations to explore and expand the lapidary meaning of the original text.

Changing circumstances and values don't always move societies toward deeper appreciation of their national parks and other protected areas. Sometimes those changes tug the opposite way, as the Amboseli situation illustrates. The current tussle to open the Arctic National Wildlife Refuge (ANWR) to oil drilling is another such instance. That tussle should alert us, if we're paying attention, to the fact that Yellowstone and Gir and Serengeti can all be de-gazetted too, whenever the relentless press of growing human populations and human demands exceeds the political resolve, in each case, to preserve something glorious for its own sake and for the sake of later generations.

Will the Maasai people regain custody of Amboseli National Park and its elephants? That's what Kenya's president has decreed, but his decision is being challenged in the courts.

In the world of conservation professionals, there is a dour saying: All our victories are temporary; only the defeats are permanent. This applies equally to the ANWR battle and the Yellowstone Act of 1872. But here's my own offering, a slightly more cheerful variant: Our national parks are as good, only as good, as the intensity with which we treasure them. □

Preserving the Wild Share your thoughts on national parks in our forum at **ngm.com/0610** and experience the wonders of a new transnational park via video stream at **ngm.com/wildcamafrica.**

THOMAS D. MANGELSEN

Our National Parks in

Glen Canyon National Recreation Area *A power plant ruptures Arizona's primordial juncture*

Peril

of sandstone and sky. A hundred years ago "we thought we could draw a line on a map and declare ■ place protected," says Roger Clark of the Grand Canyon Trust. But today some of the biggest threats to parks lie beyond their boundaries.

A REPORT CARD | PHOTOGRAPHS BY MICHAEL MELFORD

TEXT BY LYNNE WARREN NATIONAL GEOGRAPHIC WRITER

Each year more than three million people brave crowds and traffic to behold the majesty of Yosemite National Park's Half Dome and, if they're lucky, hear a ranger talk about wilderness, science, and western lore. When Congress created the National Park Service in 1916, there were already 35 national parks and monuments for the fledgling agency to manage, and about 100 million Americans to enjoy them. Today the U.S. population nears 300 million, and there are almost 400 units in the park system, from Civil War cemeteries to Arctic seashores. Staff duties have multiplied far beyond guardian and guide. In Sequoia and Kings Canyon National Parks, for example, camouflage-clad investigators (above) struggle to eradicate marijuana farms and clean up land damaged by drug growers. Budget shortfalls mean that many rangers have less time to spend with visitors. Park Service partners and "Friends" organizations try to fill the gaps. These largely volunteer groups traditionally offered the Park Service money and labor to support "a margin of excellence," says Houck Medford of the Blue Ridge Parkway Foundation. But with Park Service funding seriously compromised in recent years, he warns, "We may be forced to provide the margin of survival." The pages that follow examine some of the most pressing challenges facing our national parks, from gridlock and sprawl to invasive species and crumbling infrastructure.

Crowd Control

A fleet of hybrid diesel-electric buses runs through Yosemite Valley, and about 75 percent of the park's 3.4 million yearly visitors use the free service, but even the buses get trapped in the stink and stress of gridlock (above). Traffic plagues parks from the Great Smoky Mountains to the Grand Canyon—but not in Utah's Zion National Park. Six years ago the Park Service banned virtually all vehicles from peak-season travel on the six-mile stretch of road that connects Zion's most popular attractions. From April through October, clean, quiet propane-powered buses carry visitors through Zion Canyon (right), eliminating 4,000 vehicle-trips a day. Cost to operate the shuttles? About a dollar a year for each of the park's 2.6 million visitors. Benefits? Stress and noise down, air quality and quiet up. You can even hear the Virgin River flowing through the canyon.

STATE OF THE ROADS

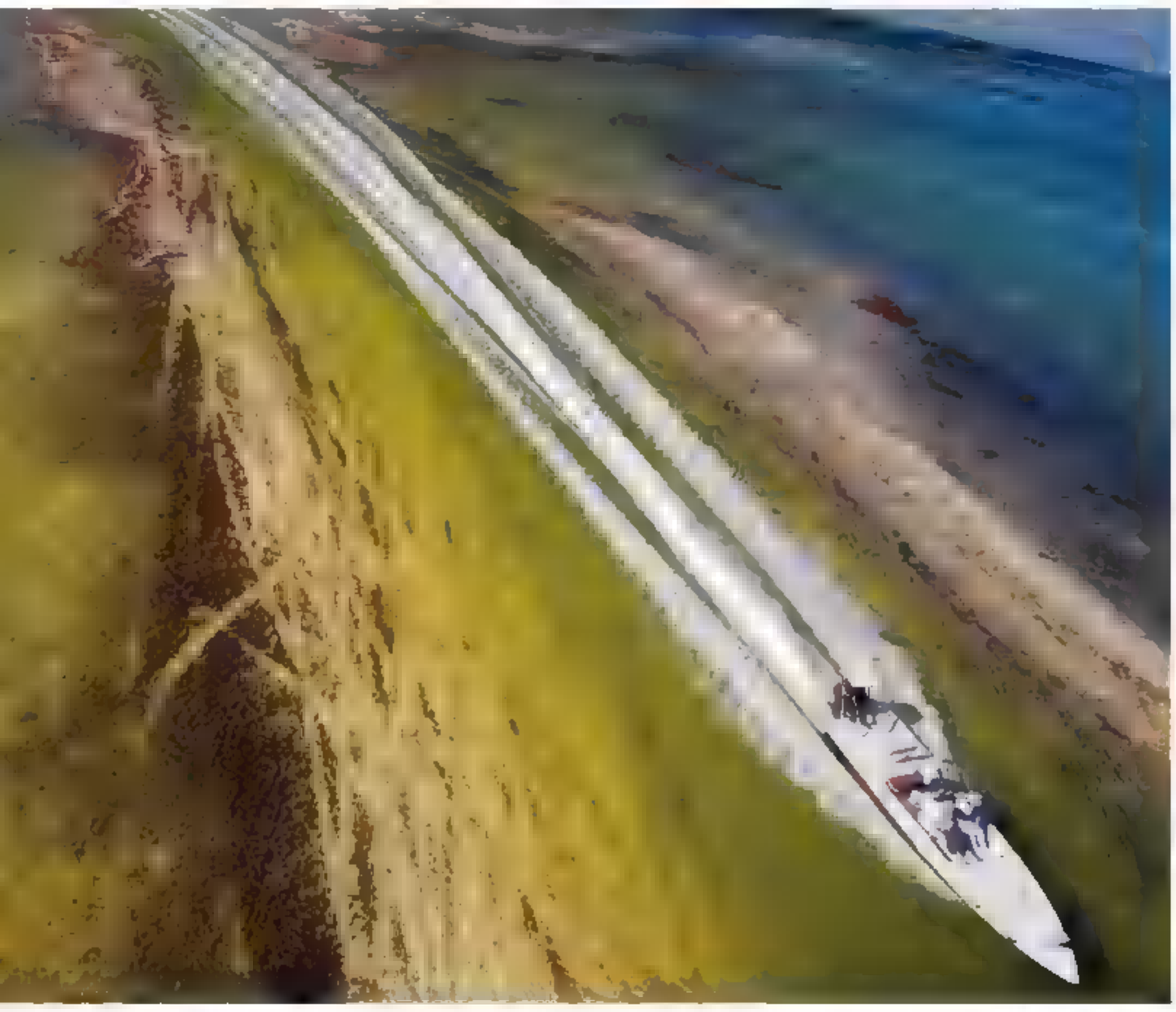
The National Park Service's backlog for road and bridge repair exceeds

$3 billion

SOURCE: NATIONAL PARKS CONSERVATION ASSOCIATION

Big Cypress National Preserve *Off-road vehicles have gouged 23,000 miles of tracks across this*

South Florida landscape. New regulations limit ORVs to 400 miles of designated trails.



Building Pressure

Rocketing numbers of boats power into the narrow, shallow channels of Florida Bay (above), often with disastrous results. Everglades National Park staff estimate that boats have damaged 10,000 acres of sea grass beds—underwater meadows that provide crucial wildlife habitat. At the edge of Biscayne National Park (right), Miami sprawl gulps up green space. Plans for a new 500-home community call for 58 acres of wetlands within its boundaries to be destroyed, and just 6.7 acres preserved. Government-mandated efforts to mitigate the development's environmental impacts cost the developer slightly less than a million dollars: the selling price of just one of its Italianate "mansions."

EDGING OUT THE ENVIRONMENT

South Florida's population growth continues to threaten the besieged Everglades ecosystem. Projected new residents by 2030

2.1 million

SOURCE: UNIVERSITY OF FLORIDA, BUREAU OF ECONOMIC AND BUSINESS RESEARCH

UNWANTED GUESTS

Invasive species are present in virtually all national parklands, costing close to $20 billion a year in damages. Area infested

2.6 million acres

SOURCE: NATIONAL PARK SERVICE

Enemies Within

Imported from Europe as garden plants, Russian olive and tamarisk threaten native willows and cottonwoods, damage soil, and disrupt wildlife habitat in Arizona's Canyon de Chelly National Monument. Money from park admission fees nationwide paid to train and equip a team of local Navajo to begin clearing the ferociously hardy shrubs from the canyon floor (left), but funding to continue the work—which park staff say will take ten years—remains uncertain. In Great Smoky Mountains National Park the battle against Europe's balsam woolly adelgid may already be lost. The insects have killed millions of Fraser firs (dead and dying trees on Clingmans Dome, above) since they were first detected in the area in 1956. The park's hemlock trees—some more than 400 years old—are now menaced by an Asian adelgid that arrived in 2002.

REPAIRS NEEDED

Historic structures in poor to fair condition

55%

Based on 26,500 structures

SOURCE: NATIONAL PARK SERVICE

All Fall Down

Battered by sea and storm, the massive walls of Fort Jefferson rise from Florida's Garden Key in Dry Tortugas National Park (left). Cast-iron frames once held shutters for cannon portals. As it rusts, the iron expands dramatically, superintendent Dan Kimball explains, "and just explodes the masonry out of the walls." The most recent effort to restore the walls began last year, but it's going to cost more than 12 million dollars to complete. "We didn't get funding this year," Kimball says, "but we're hoping to restart the project by 2008." Good news may come sooner for a small corner of Everglades National Park, thanks to local volunteer efforts and creative budgeting at park headquarters. Shut down for seven years by repeated hurricane damage and lack of maintenance funds, the Chekika recreation area (above) is slated to reopen this fall.

HELP WANTED

Hours of service donated by volunteers to the National Park Service in 2005

5.2 million

Valued at $91.5 million

SOURCE: NATIONAL PARK SERVICE

Taking Care

Wielding a painter's pole tipped with a slotted kitchen spoon, Mike Keller lifts coins, rocks, and other debris from Yellowstone National Park's Morning Glory Pool. Five winters ago the pool had turned from turquoise to dull green (above) after trash obstructed hot water circulation from the pool's vent. Yellowstone has 10,000 geothermal features but only two staff geologists. "Four of us volunteers handle thermal cleaning," Keller says. "Visitors tell us they can see the difference we make. I'm proud of that."

Gettysburg National Military Park *During the annual Remembrance Illumination, volunteer*

Paige Hisiro lights some of the 3,500 candles that honor Union soldiers who died on this Pennsylvania battlefield.

Threatened

At a period in our history notable for perishable institutions, it's reassuring to know that our national parks, after all these years, remain the best idea America ever had. A British diplomat, James Bryce, rendered that judgment in 1912 when the United States could boast but a handful of parks and a new federal agency designed to look after them wouldn't be established for another four years. How time flies. A decade from now, take away a couple of months, we'll be breaking out the bubbly to celebrate the centennial of the National Park Service. That's if, the way things have been going lately, there'll be enough high standards left untrampled to justify the toast.

The Park Service and the system it oversees have come a long way since 1916: From 14 parks, 21 monuments, and one reservation embracing six million acres to 390 areas covering 84 million acres in 49 states, the District of Columbia, and islands in the Pacific and Caribbean; from a handful of rangers to a roster of 20,000 full-time employees; from 350,000 visits a year to nearly 300 million.

And I guess I could say I've come a long way too in half a century or more as a sometime visitor or critical observer of the national parks. The memory bank is filled with the sights and sounds and scents of such crown jewels as Yosemite, Everglades, Acadia, Olympic. Curiously, however, there are memories, equally cherished, of unprotected places not yet parkland when I saw them the first time around. Mineral King, for example, that remote valley in the subalpine shadow of the High Sierra's Great Western Divide, mist rising at dawn to reveal a herd of mule deer grazing 20 yards off the starboard side of my sleeping bag. The Disney people had wanted to build a ski resort there. But they couldn't, once the valley became a part of Sequoia National Park.

I think of Battery Weed, a skeletal 19th-century fort commanding the Narrows of New York Harbor. From the top of a bluff just minutes from my house, I regarded the neglected granite fortress with sadness, for its eventual collapse seemed inevitable. I was wrong. By and by, Battery Weed would be captured by the Park Service and tidied up as a showcase feature of Gateway National Recreation Area. Rummaging around in even older memories, I see surf pounding the white sands of Nauset Beach (now Cape Cod National Seashore in Massachusetts), wind

Sanctuaries

rippling a sea of wild switchgrass in the Flint Hills of eastern Kansas (Tallgrass Prairie National Preserve), sunlight dancing across a flow of ancient lava near Grants, New Mexico (El Malpais National Monument).

Yet for all the bright memories, there's reason to fear that America's national parks may now be facing their most daunting test. The present danger goes beyond the usual alarm that the Park Service is strapped for adequate funds to maintain the parks and therefore overwhelmed by visitors who are "loving the parks to death." That of course is a huge problem, but not a new one. Budget shortfalls have harried the Park Service and the system for many decades and under many administrations. Yet the most unsettling danger over the past five years—at least until Dirk Kempthorne replaced Gale Norton as Secretary of the Interior last May and Fran Mainella announced her intent to resign as director of the Park Service—has been an atmosphere of veiled hostility created by political appointees at the highest levels of both agencies. That atmosphere not only rattled the morale of many career professionals in the field but also assaulted the legal and regulatory fabric that has effectively held the National Park System together for 90 years.

In fits and starts over those same five years, I've been taking the pulse of the Park Service and the system, talking with regional directors, park superintendents, interpretive and law enforcement rangers, and public affairs specialists. Some have retired from the agency since we spoke, a few taking early retirement rather than toeing the party line and biting their tongues behind a fixed smile. The relatively new Coalition of National Park Service Retirees now counts among its more than 500 members five former directors or deputy directors, 26 regional directors or deputies, and 130 park superintendents and assistant superintendents. Many of these former top professionals put in for retirement since 2001. "We're losing some of our best people," a ranger said to me last year at Yosemite Valley. "Where is it going to end?"

Visitors to the parks are unaware of these tensions. For all the erosion of agency morale, the wear and tear, the backlog of uncompleted maintenance and repair projects, the widespread reductions of interpretive programs, national parks can still deliver a memorable experience. With patience and binoculars, one may now observe wolves as well as bison at Yellowstone National Park. Given gravity and sufficient precipitation, Yosemite's Bridalveil Fall will continue to ensorcell viewers for years to come. But what of some of the other values of the larger Yellowstone and Yosemite? Unspoiled habitat. Wilderness. Solitude. High country silence. Is it time to begin to wonder if we are about to lose the best of these, too?

MOST HISTORIANS TRACE the origin of America's "best idea" to the frontier artist George Catlin who, in 1832, after a tour sketching the tribes of the Great Plains, expressed hope that the government might set aside a vast section of the West for "a nation's Park, containing man and beast, in all the wild and freshness of their nature's beauty." But it would be 32 years before the U.S. made its first tentative

THE PRESENT DANGER GOES BEYOND THE USUAL ALARM THAT THE PARK SERVICE IS STRAPPED FOR FUNDS TO MAINTAIN THE PARKS AND OVERWHELMED BY VISITORS.

move in that direction, transferring a federally owned Yosemite Valley and a nearby grove of sequoias to the State of California to hold in trust for the entire nation as a place for public use and recreation. Eight years later Congress established Yellowstone as our first official national park, and Yosemite went federal as a national park in 1890.

In subsequent years, other congressional mandates authorized additional parks, battlefield sites, and memorials, and the Antiquities Act of 1906 enabled a President to proclaim a national monument on federal land without congressional consent. By 1916 the U.S. Department of the Interior had jurisdiction over 35 parks and monuments, and in August of that year President Woodrow Wilson signed an act establishing within Interior a National Park Service to manage and protect those areas and others that might be authorized in the future (such as the more than 50 monuments, military sites, and other areas it took over from the Forest Service and the War Department in the 1930s).

If any decade after that was to demonstrate how far the National Park System could move beyond its traditional image, rooted in the scenic values of the big western parks, it was the 1960s—the years of President Lyndon Johnson, Secretary of the Interior Stewart Udall, and a hard-charging Park Service director named George Hartzog. Udall and Hartzog wanted to break new ground, but first Congress would have to eschew its own tradition of creating parks on the cheap, either carved from existing federal lands or purchased with other people's money, principally that of philanthropist John D. Rockefeller and his family. Enactment of the Land and Water Conservation Fund Act, primed mostly with receipts from oil and gas leasing on the outer continental shelf, soon helped the service develop a new menu of parklands: national lakeshores, wild and scenic rivers, national trails, and, last but not least in terms of visitor use and operating expense, the urban recreation areas that would fulfill Lyndon Johnson's dream of bringing nature closer to people.

If anyone feared that the rush to establish national recreation areas in or adjacent to such metropolises as New York City and San Francisco meant the end of acquiring big scenic parks in the far country, that suspicion soon faded as President Jimmy Carter moved to secure 40 million acres of federal lands in Alaska for the National Park Service, first putting them "on hold" by invoking the Antiquities Act, and then by designating nine new parks and preserves and sizably expanding existing ones, such as Denali, with passage of the Alaska National Interest Lands Conservation Act of 1980. In the stroke of a pen, President Carter had more than doubled the acreage of the National Park System.

Noting the huge responsibility that any new unit, of whatever size or category, places on the shoulders of an overextended, underfunded Park Service, a few observers began to cast a critical eye on a growing genre of historic sites commemorating not some classic or heroic moment from America's past, as in a Civil War battlefield or presidential birthplace, but rather a salute to a place or event perceived as having

Great Smoky Mountains National Park *Photographer Michael Melford used a telephoto lens to catch a park-goer just feet from battling deer. Enthralled visitors often assume—mistakenly—that roadside creatures are too tame to be dangerous.*

limited national significance, as in the case of Steamtown National Historic Site at Scranton, Pennsylvania, established to interpret the story of steam railroads in the 20th century. The purists saw danger in these designations and warned they could lead, as one top official put it, to "a thinning of the [Park Service's] blood." A misguided handful even objected to designating sites exploring the darker, often shameful side of American history, as at Manzanar in California's Owens Valley, where thousands of innocent Japanese-American citizens were interned during World War II. But a reluctance to open all aspects of our history to a fuller interpretation soon passed away. Even the old Custer Battlefield National Monument in Montana would acquire a fresh look and a new name—Little Bighorn Battlefield National Monument—to give an accurate account of the Lakota, Cheyenne, and Arapaho side of the story.

Nineteen-ninety-three was the last time the

"IN GIVING PRIORITY TO VISITOR SERVICES, THE PARK SERVICE HAS PAID LESS ATTENTION TO THE RESOURCES IT IS OBLIGED TO PROTECT FOR FUTURE GENERATIONS."

editors of this magazine posted me across the country to assess the state of the national parks. I didn't hear too much grumbling then about thinned blood or revisionist history. But what I did hear from rank and file in the Park Service was a huge concern that the nation's treasures were threatened by industrial and automotive air pollution, invasive species, and a variety of human encroachments nibbling at the edges of hallowed ground. The most persistent complaint, however, was a perception that the Park Service had lost its ability to protect natural and cultural resources, largely because its rangers had morphed into traffic cops to accommodate growing throngs of park-loving visitors. All these problems and many more continue to plague the service and the system—notably the contentious issue of protection versus use.

The legislation establishing the National Park Service 90 years ago, the so-called Organic Act, stipulated that the purpose of parks and monuments—indeed, the agency's core mission—"is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." But over the years there has been much disagreement over which comes first, the resource or the visitor. Not only that, but at what point does resource impairment begin to result from a good time being had by all?

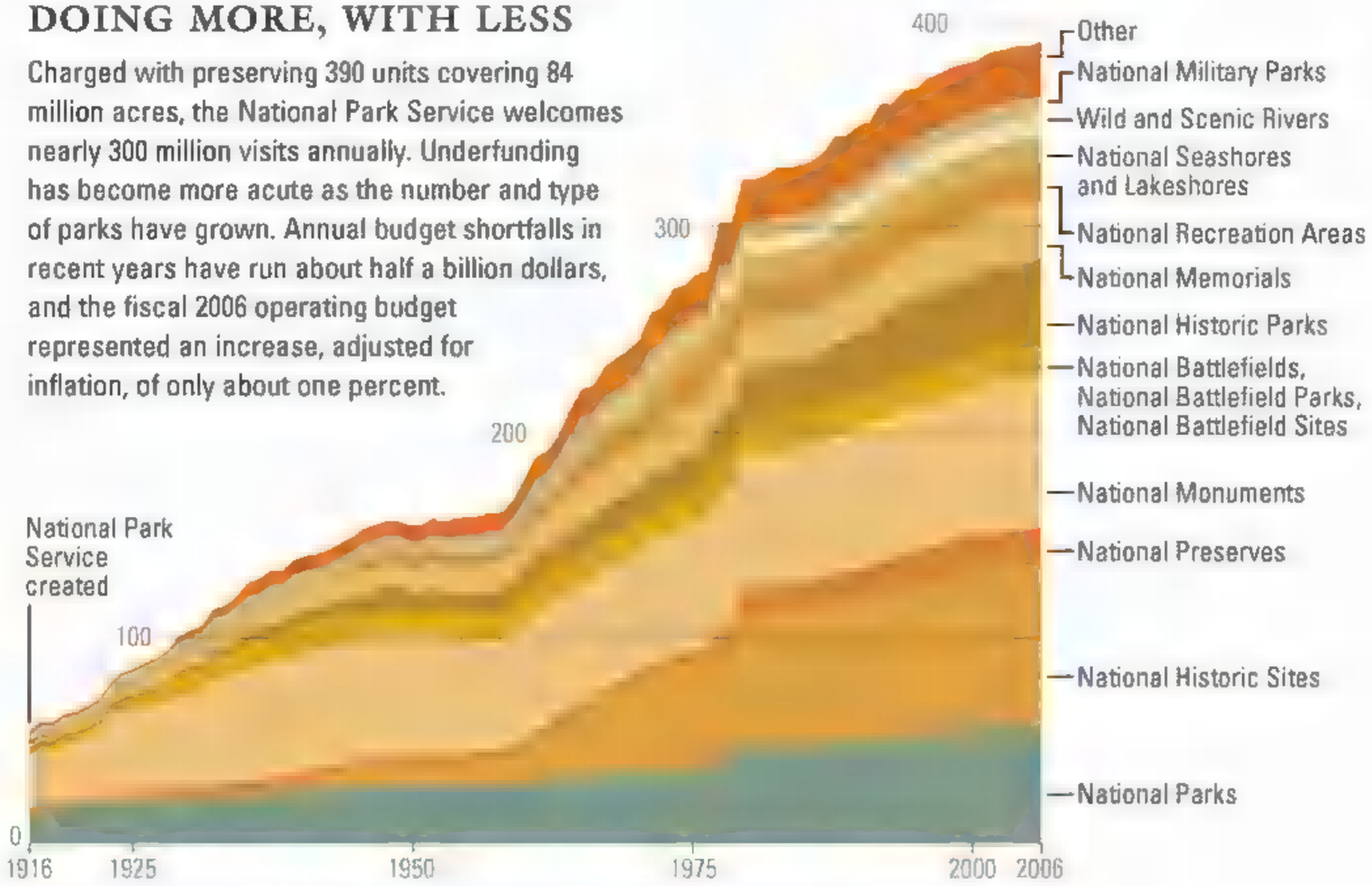
Five years ago the National Park System Advisory Board, a distinguished panel appointed by the Secretary of the Interior, issued a report describing how the Park Service, early on, had discovered that the best way to win public support for the parks was to make sure the visitors derived pleasure from them. However, managing for people (as in the suppression of forest fires) often resulted in bad news for resources (a buildup of forest debris fueling deadlier fires). "It is time," the board declared in *Rethinking the National Parks for the 21st Century,* "to re-examine the 'enjoyment equals support' equation and to encourage public support of resource protection at a higher level of understanding. In giving priority to visitor services, the Park Service has paid less attention to the resources it is obliged to protect for future generations."

For the most part career professionals in the Park Service found the report much to their liking. But that was not the reaction among political appointees in the Bush Administration. Though Park Service Director Fran Mainella initially supported the report, it later became evident that it was not her agenda, and before long the Department of the Interior, under Secretary Norton, was suggesting the opposite of what the board had concluded: Preservation was trumping recreation; the Clinton Administration had taken the fun out of national parks. Now the stage was set for a clash of values.

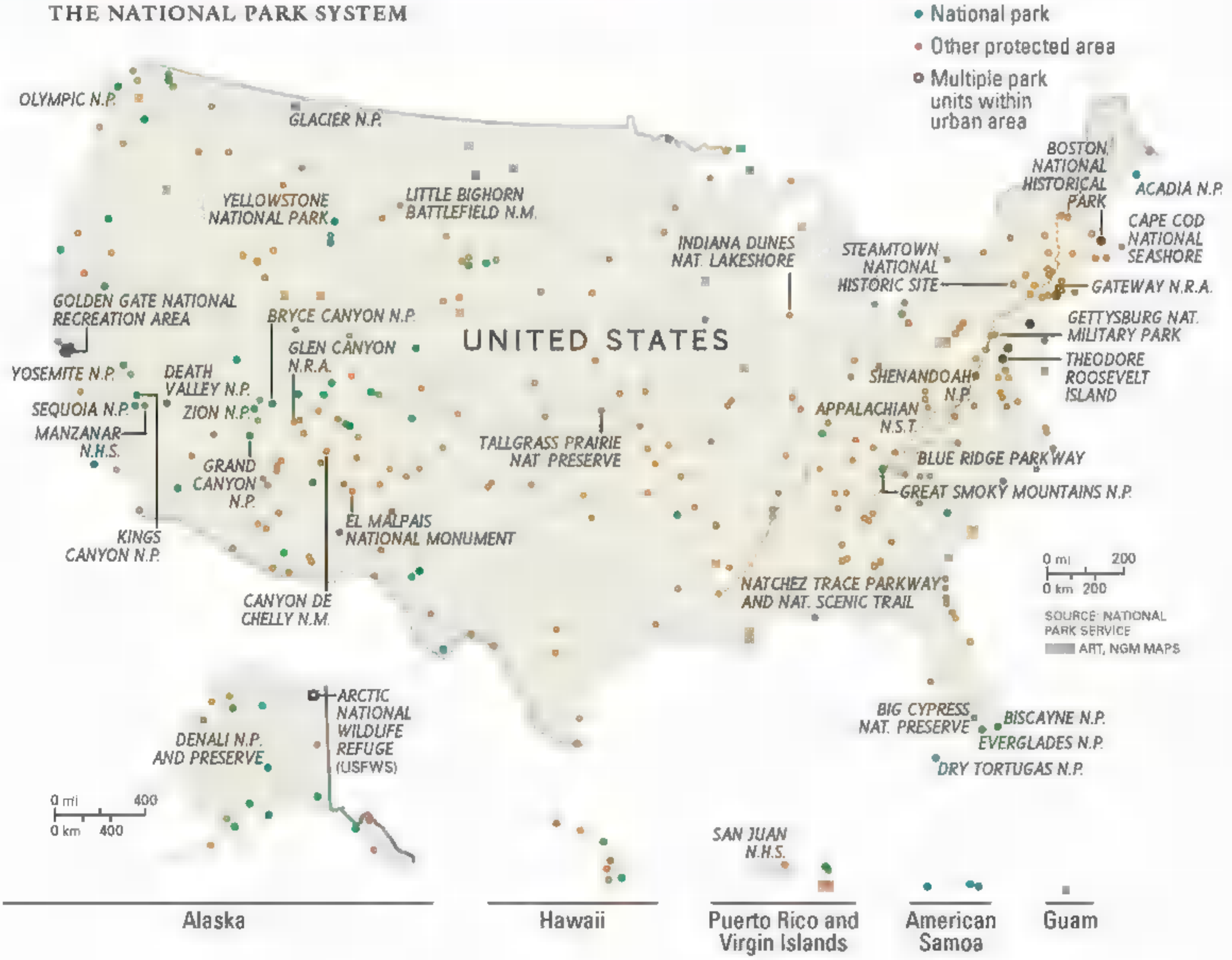
In the summer of 2005, Interior was obliged to make public—after it was leaked—a 195-page revision of the Park Service's basic policy document, essentially altering the way parks were to be managed in the future. The rewrite was the work of Paul Hoffman,

DOING MORE, WITH LESS

Charged with preserving 390 units covering 84 million acres, the National Park Service welcomes nearly 300 million visits annually. Underfunding has become more acute as the number and type of parks have grown. Annual budget shortfalls in recent years have run about half a billion dollars, and the fiscal 2006 operating budget represented an increase, adjusted for inflation, of only about one percent.



THE NATIONAL PARK SYSTEM



at the time Interior's deputy assistant secretary for fish, wildlife, and parks, a former executive director of the Cody, Wyoming, chamber of commerce, and congressional aide to Dick Cheney in the 1980s. Among Hoffman's most radical policy tweaks were calls to open to snowmobiles all national park roads used by motor vehicles in other seasons, as well as a relaxation of restrictions on personal watercraft at some national seashores and lakeshores and on noisy tourist flights over such parks as Great Smoky Mountains and Glacier.

Charging that these revisions would override 90 years of established laws and court rulings, more than a few park superintendents expressed alarm. "I hope the public understands that this is a threat to their heritage," J. T. Reynolds, superintendent at Death Valley National Park, told the *Los Angeles Times*. Bill Wade, for many years superintendent of Shenandoah National Park but now retired and speaking as chairman of the Coalition of National Park Service Retirees, called the Hoffman document an "astonishing attempt to hijack" the nation's parks "and convert them into vastly diminished areas where almost anything goes." And it came as no surprise that the rewrite paid scant attention to the importance of promoting science-based programs in the national parks.

Oceanographer Sylvia Earle, a National Geographic Society explorer-in-residence, and a panel of her peers, including Harvard biologist E. O. Wilson, had already filed a report urging the Park Service to "continue to develop a robust, professional scientific natural resource management program." The group insisted that "it is absolutely essential for scientific knowledge to form the foundation for any meaningful effort to preserve ecological resources in the National Park System." Approved by the National Park System Advisory Board, the Earle report was forwarded to Park Service Director Fran Mainella. But the report was never printed and distributed and did not show up on the Park Service website for seven months.

Michael Soukup is the agency's associate director for natural resource stewardship and science, and he is not inclined to bite his tongue when asked if scientific expression was being sidelined in the National Park System. Until recent changes at Interior, he told me, "Science was not only being sidelined. It was under siege."

AFTER A STORM OF PROTEST within the Park Service and an outcry in the press, Mainella's office last fall issued for public comment a muted version of the Hoffman policy rewrite. ("Hoffman Lite," some critics called it.) Some of the original policy changes favoring motorized recreation were toned down or eliminated altogether, but still intact was the challenge to the primacy of protection over use. Senate and House committees charged with oversight of the National Park System conducted hearings. Possibly the most persistent criticism heard was that a rewrite of a bad policy revision was without merit or justification. "To polish the apple when it is rotten at its core is a waste of time," said Bill Wade, the retired Shenandoah superintendent,

PRESERVATION WAS TRUMPING RECREATION; THE CLINTON ADMINISTRATION HAD TAKEN THE FUN OUT OF NATIONAL PARKS. NOW THE STAGE WAS SET FOR A CLASH OF VALUES.

referring to the attempt to lighten up Hoffman Heavy. Nonetheless, the Senate Subcommittee on National Parks heard one William Horn testify that Clinton-era policy was "overtly hostile" to traditional use. Visitors, he said, shouldn't be kept "on the other side of the . . . fence." Horn identified himself as a former Interior assistant secretary for fish, wildlife, and parks in the Reagan Administration but neglected to mention his current position as an attorney for the International Snowmobile Manufacturers Association.

Rebutting Horn's argument was Denis Galvin, a retired deputy director of the Park Service who served under three Presidents and who did identify his current affiliation as a trustee of the National Parks Conservation Association, a nonprofit advocacy organization. Galvin wondered how people could feel fenced out when tens of millions of them visit national parks every year and almost invariably respond in surveys that they thoroughly enjoy the experience. "The national parks do not have to sustain all recreation," he said. "That is why we have various other federal, state, local, and private recreation providers . . . to provide for those types of recreation that generally do not belong in the national parks."

Speaking at the House Resources Committee hearing a few months later, Stephen Martin, deputy director of the National Park Service, questioned, in effect, what all the fuss was about. Denying there had been any attempt to manipulate the agency's core mission, Martin testified that the new draft policies "underscore that when there is a conflict between use and conservation, the protection of the resource will be predominant." That interpretation, in fact, was strongly endorsed with the release in June of yet another draft, which rejected earlier revisions, conceded virtually every point of contention, and returned to the original policies the revisionists had sought to undercut.

The House Resources Committee, presided over by Richard Pombo (R-Calif.), broke briefly into the news earlier this year when Pombo's staff drafted a budget reconciliation proposal to sell off 15 national park areas for commercial or energy development and slather the remaining units with paid advertisements on park shuttle buses. Among the places on the hit list, each selected for its failure to attract more than 10,000 visitors a year, were seven remote and wild areas in Alaska totaling some 19 million acres. Pombo's staffers also proposed turning the wooded 88-acre Theodore Roosevelt Island in the Potomac River—the capital city's fitting memorial to the President who put an uppercase C on the word Conservation—into a conclave of offices and condominiums.

These proposals did not rest well with members of Congress. Pombo's staff rushed to deflate their significance, describing them as a "theoretical exercise" and a "joke." The boss didn't really want to sell off national parks, it was said. Some budget-watchers suggested it was a ploy to demonstrate what it would take to offset the loss of anticipated federal revenue should obstructionists continue to block oil drilling in the Arctic National Wildlife Refuge.

Campaigning for the presidency in 2000,

THIS YEAR, IN ITS BUDGET REQUEST FOR FISCAL 2007, THE WHITE HOUSE PROPOSED CUTTING THE PARK SERVICE'S BUDGET BY 5 PERCENT, OR A HUNDRED MILLION DOLLARS.

George W. Bush pledged that, if elected, he would wipe out the huge 4.9-billion-dollar backlog in deferred maintenance of the national parks' crumbling infrastructure. Given the fallout from 9/11, among other things, it was not to be. This year, in its budget request for fiscal 2007, the White House proposed cutting the Park Service's budget by 5 percent, or a hundred million dollars. Most of those missing dollars would come off the top of the service's construction and major maintenance funds, prompting the *New York Times* to suggest in a lead editorial that such deliberate cuts "could create the necessary cover for opening the parks to more commercial activity."

A concern that parks might be turned into profit centers developed several years ago when the Interior Department and parks director Mainella began studying the possibility of outsourcing certain services, such as landscaping, to competitive contractors. At the time, the initiative's targets were limited to a handful of jobs. Last year it appeared that the outsourcers were considering something broader when Mainella was directed to issue a memo announcing that entire programs at three parks—Boston National Historical Park, Indiana Dunes National Lakeshore, and San Juan National Historic Site in Puerto Rico—would be studied for possible handoffs to the lowest bidders. Mainella later rescinded her memo. But the specter of commerce-in-the-parks would not soon go away. Last fall the director's office proposed that superintendents be permitted to solicit corporate donations and then reward donors by displaying their brand names on prominent park facilities. In the face of strong public protests, the director's office reversed itself once again and issued new guidelines applauded even by some park advocacy organizations.

"Philanthropy has long been a tradition in the National Park System," John Piltzecker, head of the service's donations and fundraising programs, told me. He noted that "Friends" groups, cooperating associations, and the National Park Foundation already pour more than 75 million dollars into the parks annually, and he assured me that efforts will continue to keep donor recognition "low profile" and "in good taste."

Despite the institutional hiccups over the past five years, the next ten could prove a bit less bleak for the National Park Service. Two presidential elections will fall into that time frame, and the first one will usher in a new administration regardless of which party wins. In my sorties afield, I discovered that some of the service's remnant best people are toughing it out under their Smokey Bear hats. "The glass is half full, not half empty," says Gary Davis, chief scientist for ocean programs in the National Park System. At Pacific West Regional headquarters in Oakland, California, Jon Jarvis, the director, pegs his own hopefulness to the Organic Act, which obliges the Park Service to hold the parks in trust for "future generations." That's the law, says Jarvis, "and unless it's repealed, you can't get any more optimistic than that."

But what will those future generations be like? Certainly not like mine. Diversity is leaving its mark on the demographics of

Gateway National Recreation Area *A two-dollar subway ride from Manhattan, Gateway "gives people a little space to breathe, a place to walk, and maybe a moment to be alone," says Friends of Gateway Director Dave Lutz. "But it has never had the staff or money it needs to realize its potential."*

the United States. Euro-Americans, as non-Hispanic whites are often called nowadays, already are a minority in some regions of the country. "We've been talking all these years to the people who come to the parks," says Howard Levitt, chief of interpretation at Golden Gate National Recreation Area in San Francisco. "Now we must learn how to speak with the people who haven't been coming."

Levitt's boss, Golden Gate Superintendent Brian O'Neill, told me 13 years ago that his agency's fundamental challenge would be to make every individual in an increasingly diverse population "a real stakeholder, emotionally and intellectually, in the National Park System." Was that still the challenge, I asked O'Neill when I saw him recently. "You bet it is," he said. "Now more than ever." □

Park Priorities What's more important: preserving nature or providing recreation? Share your view on our weblog at **ngm.com/0610.**

Urban Downtime

The City of Light is also a city of green, with a panoply of parks and gardens where Parisians rest and rejuvenate.

PHOTOGRAPHS BY AMY TOENSING

ABOVE: SQUARE WILLETTE, BASILIQUE DU SACRÉ CŒUR

A linear lid atop an abandoned 19th-century railroad viaduct, the Promenade Plantée runs almost three miles through urban neighborhoods in eastern Paris from Place de la Bastille to the Bois de Vincennes. From dawn to dusk, its lush gardens offer walkers a long ribbon of green relief from noise and traffic. Sheltered in the viaduct's arches are artisans' workshops and galleries open at street level.

Soup's on at the Jardin Nomade, a community garden tucked between two busy streets east of the Bastille. Built on a derelict lot vacant for almost ten years, the garden now offers neighborhood residents small plots for growing vegetables and flowers. Monthly soup dinners featuring recipes from around the world draw more than a hundred people.

A leafy haven beckons to lovers out for a stroll. The Square du Vert-Galant, perched on the western tip of Île de la Cité in the Seine, was named for the dashing 16th-century king of France, Henri IV, known as the lusty gallant. Today the garden is a popular spot for marriage proposals.

Benches beckon on the Pont des Arts, a pedestrian bridge across the Seine, testifying to the Parisian belief that the human backside is a dimension that should never be forgotten. Many public places in Paris harbor benches and, often, movable chairs that encourage rest and sociable lingering.

Mature chestnut trees tower over the Place Dauphine, a small triangular plaza on Île de la Cité. Some 483,000 trees of 120 species green the public squares, streets, parks, and gardens of Paris—the fruit of efforts over the past century that continue today: Each year the city plants 2,400 new trees.

CITY PARKS | BY JENNIFER ACKERMAN

Space for the

That we should find nature rejuvenating is hardly surprising. After all, our tribe arose not in cinderbelt but in wild forests and grasslands. Our ears are made not for the stinging scream of sirens but for the sly scratch of a predator's paws and the whistle of wind that warns of impending weather. Our eyes evolved to tease apart not the monotonous grays of cityscapes but the subtle gold, olive, and burgundy hues that signaled ripe fruit and tender leaves, and our brains to reward our sensory efforts with feelings of deep pleasure.

Could this be why the citizens of Paris work so hard to reinvent dead urban space and neglected squares of hardscape as places of vibrancy and green? Consider Parc des Buttes-Chaumont in the city's crowded 19th arrondissement. Once this patch of land held an old gallows, then a gypsum quarry, then the city dump. Now the big bucolic park of grassy slopes and grottoes is alive with bloom and birdsong and a healthy jumble of people who spill onto its hilly lawns: kickboxers, musicians, university students perusing their notes or memorizing lines for a play, lovers rolling over one another like tumblers, and old men who have settled themselves on the grass to rest.

Parisians in fact will seize just about any spot in their city for park or garden: tiny balcony, abandoned auto plant, bankrupt parking garage, derelict railway, even the giant curved facade of a new museum. They will sacrifice broad boulevards for the sake of bike paths with leafy canopies. They will argue for community gardens over apartments or media centers. They will relinquish a busy city expressway along the Seine for a temporary beach park, and will see in every shabby lot a prospective cathedral of green.

Why are citizens of the City of Light so intent on finding space for parks and gardens, for street trees and nature strips? For that matter, why would any city go to the bother and expense of growing green space in the stone and steel of an urban environment? At a time when half the world's population lives in cities (a proportion expected to grow to 60 percent by 2030) and funds may be scarce for urban housing, schools, social services, fire and police protection, this is no trivial question.

Soul

Sweeping green playing fields at the Jardin de Reuilly stay closed, like many other park lawns in Paris, through early spring; signs say "pelouse au repos," *or lawn at rest. Then one day in April, the lush expanses open to an exuberant public—for picnics, soccer, or simple, giddy soaring with Grandma.*

It's true that in Paris, as in many other cities, parks and gardens are a luxury. "But they are also essential," says Martine Petelot, a member of the Jardin Nomade, a small community garden on a vacant lot in the congested 11th arrondissement. "Our garden allows us to work the earth, to watch things grow. People need to scratch about in the soil, breathe in the scent of plants and flowers, let off steam, and meet other people. For many, it's almost like therapy."

If the recent renaissance in urban parks and public spaces is any indication, many city residents and planners share Petelot's perspective. The past five to ten years have seen an explosion of tree planting in cities and the creation of new parks and public gathering spots—a revolution inspired in

WHY WOULD ANY CITY GO TO THE BOTHER AND EXPENSE OF GROWING GREEN SPACE IN THE STONE AND STEEL OF AN URBAN ENVIRONMENT?

part by new science. A growing body of research suggests that spaces filled with leafy vegetation filter pollution and trap tiny particles of dirt and soot: Street trees can reduce airborne particulates from car and bus exhaust. Large groves of trees may have an even more profound green-lung effect for cities, cleansing the air of dangerous chemicals. In Chicago, scientists found that each year trees removed some 234 tons of particulates, 98 tons of nitrogen dioxide, 93 tons of sulfur dioxide, and 17 tons of carbon monoxide.

Tree leaves block sunlight as well, cooling islands of heat generated by hard city surfaces. The temperature of asphalt or concrete under a shade tree can be as much as 36°F cooler than a patch of pavement in full summer sun; the air up under the canopy of mature trees may be five to ten degrees cooler.

PARKS AND GARDENS are also essential to human social and psychological well-being. Without access to grass and trees, says Frances Kuo, we humans are very different creatures. For the past decade, Kuo and her colleagues at the Landscape and Human Health Laboratory of the University of Illinois have researched the effects of green space on city dwellers. The team carries out many of its studies in Chicago's public housing neighborhoods, where barren expanses of hardscape reflect the old view that vegetation is an extravagance the city can't afford.

One sequence of studies focused on residents of the Robert Taylor Homes, a cluster of 28 identical high-rise buildings, now mostly torn down, that formed the nation's largest public housing development. Some of the buildings were surrounded by grass and trees, others by concrete and asphalt. Kuo and her team discovered that people living in buildings near green areas had a stronger sense of community and coped better with everyday stress and hardship. They were less aggressive and less violent, they performed better on tests of concentration, they managed their problems more effectively.

They also felt safer—and with good reason. In one of its more startling findings, the team upended the common belief that barren spaces are safer than green ones. A study of violent crime in a housing project of 98 apartment buildings showed that in and around buildings near vegetation that didn't hamper visibility there were only half as many crimes as in areas near no vegetation. The greener the surroundings, says Kuo, the lower the crime rate against people and property. The team also found less litter and graffiti in natural landscapes.

In their most recent research, a national study of 450 children ages five to eighteen, the scientists discovered that children with attention deficit disorders showed reduced symptoms when they were exposed to natural environments. After play in verdant settings, parents reported that the children's ability to concentrate, complete tasks, and follow directions improved dramatically—in all age groups, in all parts of the country.

Why would vegetation influence our mental well-being? For one thing, grass and trees provide a welcoming place for people to

Anchored by the Bois de Boulogne in the west and the Bois de Vincennes in the east, Paris's 450 parks and gardens cover more than 7,400 acres—almost 30 percent of the city's surface—making it one of Europe's greenest cities.

gather. In the hectic and crowded cores of cities, people need the little grove of chestnut trees outside their apartments where they can mingle in the shade and hear the hiss of wind in high trees. They need big public lawns where they can play together. They need the tiny sprouting plots of neighborhood gardens, where they can put aside the city's stress on time and the temporary in favor of growth and permanence.

Scientists suspect that green space also has a restorative effect on our voluntary attention, the kind of intense focus required to work or study, to ignore distractions and concentrate on the task at hand. Voluntary attention is like a mental muscle; we exercise it in nearly every aspect of our lives. It dictates how well we think and how we handle ourselves in difficult situations—whether we roll with the punches or fly off the handle. Living in a city with its relentless crush of noise and traffic, conflicts and demands, makes us "crabby and impulsive," Kuo says. Being in nature refreshes us by letting us give voluntary attention a rest and allowing us to surrender to involuntary attention: the effortless and often enjoyable noticing of sensory stimuli in our environment.

Kuo speculates that over the course of human evolution, there was selection for this response to the natural world. Our ancestors who found nature effortlessly engaging had an advantage. "They were the ones more likely to know where the berries could be found and where the critters hung out," she says. "When push came to shove in difficult environmental conditions, they were better able to survive."

In our modern era, with all its pressures, contact with nature in urban settings may be

LIVING IN A CITY, WITH ITS RELENTLESS CRUSH OF NOISE AND TRAFFIC, CONFLICTS AND DEMANDS, MAKES US "CRABBY AND IMPULSIVE," KUO SAYS.

more crucial than ever. A park-rich metropolis helps us stay physically healthy and battle overweight and diabetes. Two big recent studies of people in populated urban centers in the Netherlands and Japan showed that those living in areas with easy access to green spaces where they could walk had significantly better health and lower mortality rates than those without. Health studies suggest that even relatively passive contact with nature lowers blood pressure and anxiety levels.

POLITICIANS AND PLANNERS may be getting the message. In 2003, the U.S. Conference of Mayors passed an urban forestry resolution to promote the preservation and new growth of trees and forests in city environments. Two years later, 50 city leaders from around the globe signed a Green Cities Declaration at the United Nations World Environment Day in San Francisco. Mayors from Delhi to Dakar, Moscow to Manila, resolved to chart a bold new course for the urban environment, launching efforts to reduce waste and pollution, ease traffic congestion, and—by the year 2015—to ensure an accessible public park or recreational open space within a third of a mile of every city resident.

"Reclaiming space so that a city can 'breathe' is an integral part of the challenges confronting urban civilization today," says Bertrand Delanoë, the popular mayor of Paris. "A modern city needs areas free from density, noise, and the frenzied urban pace. We must re-create the kinds of spaces that lend themselves to talking, walking, discovering, relaxing."

When Delanoë ran for office six years ago, a centerpiece of his campaign was a pledge to find, within city limits, 75 acres for new parks and public spaces. In a metropolis as densely settled as Paris, this is no easy task. But Mayor Delanoë and his staff are recycling land with characteristic Parisian creativity and verve, rescuing bits and pieces of the city to create new parks.

Among them is Un Tracé de Verdure sur les Maréchaux, a linear greenway to be planted along a tram route in the south of Paris, and the Jardins d'Eole, a soon-to-open informal ten-acre people's park where residents of the working-class neighborhoods of the northern 18th arrondissement can picnic and play on fields that were once train yards. With these and other small parks and public spaces, including some of the 40 or so vibrant community gardens that have cropped up on vacant lots all over the city, Delanoë's promise will likely be fulfilled.

Champions of urban parks hail recent progress in the greening of cities but warn that much remains to be done. Some leaders consider their cities all built up, with no room for more parkland, says Peter Harnik, director of the Center for City Park Excellence at the Trust for Public Land in Washington, D.C. But if a city has space for one more building, Harnik posits, it has room for one more park.

As for footing the bill: Cities have traditionally reserved funds for such requisites as police, sewers, and fire trucks, and considered parks and green space as pleasant amenities—investments for leftover money. But researchers such as Frances Kuo argue

One of the few Paris parks open all day and night, the Parc du Champ de Mars welcomes humans and their canine companions. On hot summer nights, the giant geometric lawns draw Parisians from all quarters who spread out their blankets under the lights of the Eiffel Tower for evenings of music, dog play, and alfresco dining.

that parks in cities represent a minor public investment with a huge payoff. "Parks help people take care of themselves so cities don't have to spend as much on social, medical, and safety services trying to fix their problems," she says.

What then should be the goal of city planners? A park near every doorstep where people can gather and gain a healthy dose of that remedy Henry David Thoreau said we can never have enough of: nature. □

Serene Green Explore more of Paris's parks in an online-exclusive photo gallery. Then tell us about your favorite urban parks in a blog at **ngm.com/0610.**

THE POLLUTION WITHIN

[illegible] the [illegible] of a [illegible] [illegible] out decades [illegible] paint [illegible] still [illegible] swallow it.

Thanks to modern chemistry, eggs don't stick to the pan, underarms are fresh all day, SUVs hit 60 in six seconds. But such convenience has a price: Chemicals that suffuse modern life—from well-known toxins to newer compounds with unknown effects—are building up in our bodies and sometimes staying there for years.

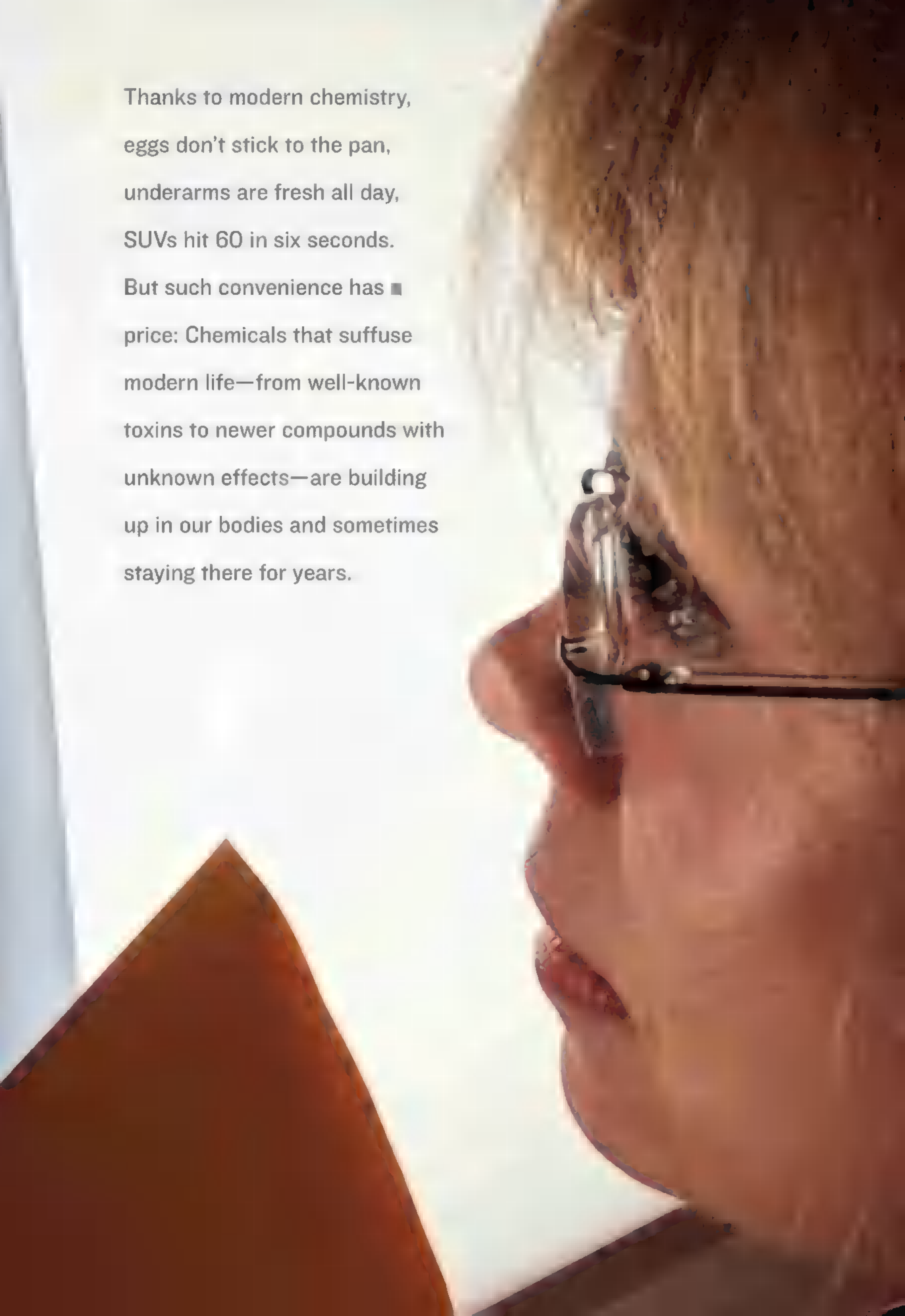


PHOTO OF QUINT: AMELIA DAVIS

There's no proof that chemicals wafting from factories triggered breast cancer in three women who lived in Richmond, California. But Marleen Quint, with graphic proof of her ordeal, suspects living in sight of the plants was a factor. "My mother is 79 and has all her body parts." Quint, Wanna Wright, center, and Etta Lundy hope to force a nearby oil refinery to reduce "flaring" of excess gases.

By **David Ewing Duncan**

Photographs by **Peter Essick**

My journalist-as-guinea-pig experiment is taking a disturbing turn.

A Swedish chemist is on the phone, talking about flame retardants, chemicals added for safety to just about any product that can burn. Found in mattresses, carpets, the plastic casing of televisions, electronic circuit boards, and automobiles, flame retardants save hundreds of lives a year in the United States alone. These, however, are where they should not be: inside my body.

Åke Bergman of Stockholm University tells me he has received the results of a chemical analysis of my blood, which measured levels of flame-retarding compounds called polybrominated diphenyl ethers. In mice and rats, high doses of PBDEs interfere with thyroid function, cause reproductive and neurological problems, and hamper neurological development. Little is known about their impact on human health.

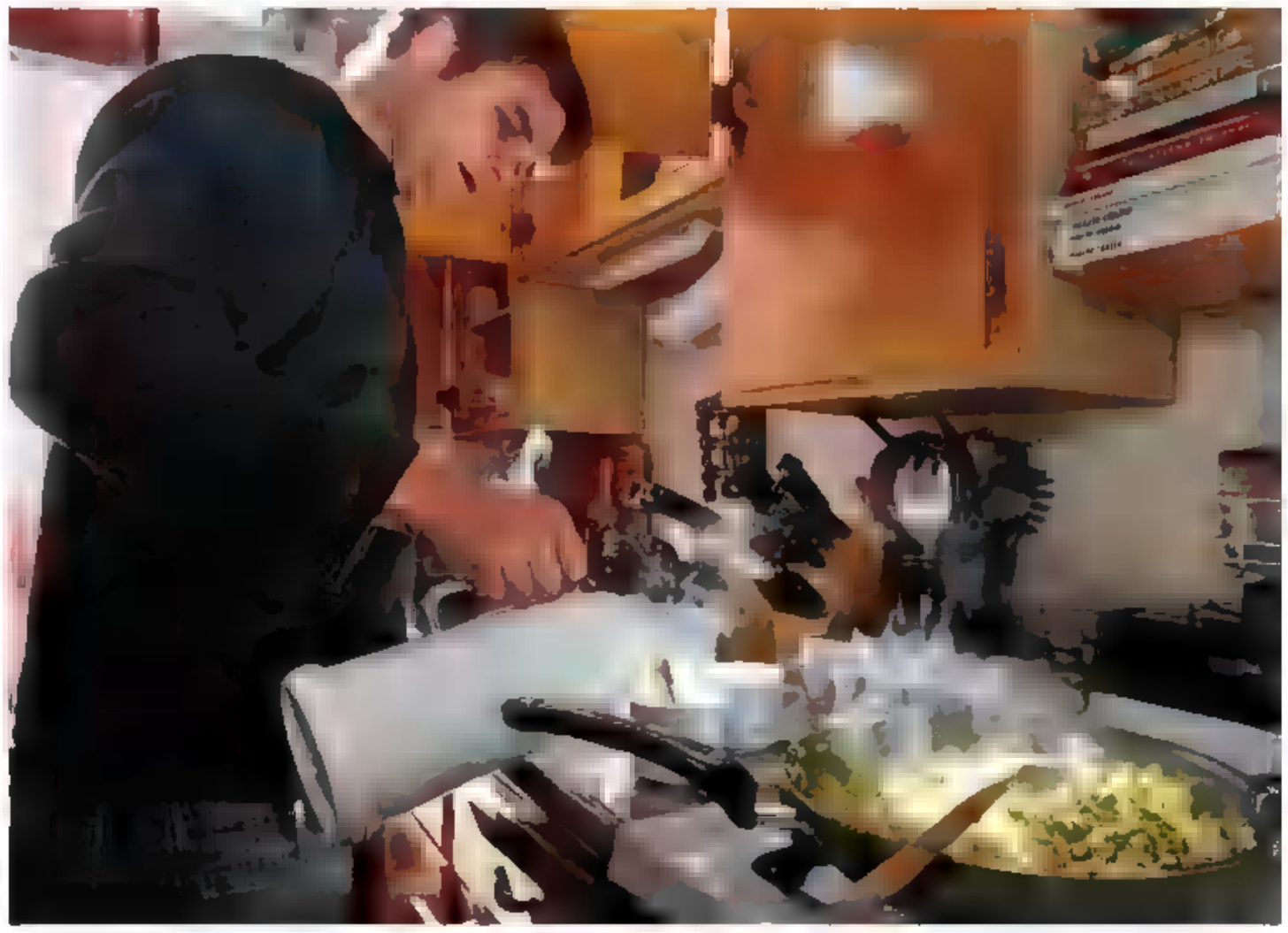
"I hope you are not nervous, but this concentration is very high," Bergman says with a light Swedish accent. My blood level of one particularly toxic PBDE, found primarily in U.S.-made products, is 10 times the average found in a small study of U.S. residents and more than 200 times the average in Sweden. The news about another PBDE variant—also toxic to animals—is nearly as bad. My levels would be high even if I were a worker in a factory making the stuff, Bergman says.

In fact I'm a writer engaged in a journey of chemical self-discovery. Last fall I had myself tested for 320 chemicals I might have picked up from food, drink, the air I breathe, and the products that touch my skin—my own secret stash of compounds acquired by merely living. It includes older chemicals that I might have been exposed to decades ago, such as DDT and PCBs; pollutants like lead, mercury, and dioxins; newer pesticides and plastic ingredients; and

the near-miraculous compounds that lurk just beneath the surface of modern life, making shampoos fragrant, pans nonstick, and fabrics water-resistant and fire-safe.

The tests are too expensive for most individuals—NATIONAL GEOGRAPHIC paid for mine, which would normally cost around $15,000—and only a few labs have the technical expertise to detect the trace amounts involved. I ran the tests to learn what substances build up in a typical American over a lifetime, and where they might come from. I was also searching for a way to think about risks, benefits, and uncertainty—the complex trade-offs embodied in the chemical "body burden" that swirls around inside all of us.

Now I'm learning more than I really want to know.



AUTHOR DAVID EWING DUNCAN COOKS BREAKFAST AT HOME. ON THE MENU: PBDEs, PHTHALATES, PCBs, AND A SIDE OF PFAs.

Bergman wants to get to the bottom of my flame-retardant mystery. Have I recently bought new furniture or rugs? No. Do I spend a lot of time around computer monitors? No, I use a titanium laptop. Do I live near a factory making flame retardants? Nope, the closest one is over a thousand miles away. Then I come up with an idea.

"What about airplanes?" I ask.

"Yah," he says, "do you fly a lot?"

"I flew almost 200,000 miles last year," I say. In fact, as I spoke to Bergman, I was sitting in an airport waiting for a flight from my hometown of San Francisco to London.

"Interesting," Bergman says, telling me that he has long been curious about PBDE exposure inside airplanes, whose plastic and fabric interiors are drenched in flame retardants to meet safety standards set by the Federal Aviation Administration and its counterparts overseas. "I have been wanting to apply for a grant to test pilots and flight attendants for PBDEs," Bergman says as I hear my flight announced overhead. But for now the airplane connection is only a hypothesis. Where I picked up this chemical that I had not even heard of until a few weeks ago remains a mystery. And there's the bigger question: How worried should I be?

The same can be asked of other chemicals I've absorbed from air, water, the nonstick pan I used to scramble my eggs this morning, my faintly scented shampoo, the sleek curve of my cell phone. I'm healthy, and as far as I know have no symptoms associated with chemical exposure. In large doses, some of these substances, from mercury to PCBs and dioxins, the notorious contaminants in Agent Orange, have horrific effects ("A World of Hurt," page 139). But many toxicologists—and not just those who have ties to the chemical industry—insist that the minuscule smidgens of chemicals inside us are mostly nothing to worry about.

"In toxicology, dose is everything," says Karl Rozman, a toxicologist at the University of Kansas Medical Center, "and these doses are too low to be dangerous." One part per billion (ppb), a standard unit for measuring most chemicals inside us, is like putting half a teaspoon of red dye into an Olympic-size swimming pool. What's more, some of the most feared substances, such as mercury, dissipate within days or weeks—or would if we weren't constantly re-exposed.

Yet even though many health statistics have been improving over the past few decades, a few illnesses are rising mysteriously. From the early 1980s through the late 1990s, autism increased tenfold; from the early 1970s through the mid-1990s, one type of leukemia was up 62 percent, male birth defects doubled, and childhood brain cancer was up 40 percent. Some experts suspect a link to the man-made chemicals that pervade our food, water, and air. There's little firm evidence. But over the years, one chemical after another that was thought to be harmless turned out otherwise once the facts were in.

The classic example is lead. In 1971 the U.S. Surgeon General declared that lead levels of 40 micrograms per deciliter of blood were safe. It's now known that any detectable lead can cause neurological damage in children, shaving off IQ points. From DDT to PCBs, the chemical industry has released compounds first and discovered damaging health effects later. Regulators have often allowed a standard of innocent until proven guilty in what Leo Trasande, a pediatrician and environmental health specialist at Mount Sinai Hospital in New York City, calls "an uncontrolled experiment on America's children."

Each year the U.S. Environmental Protection Agency reviews an average of 1,700 new compounds that industry is seeking to introduce. Yet the 1976 Toxic Substances Control Act requires that they be tested for any ill effects before approval only if evidence of potential harm exists—which is seldom the case for new chemicals. The agency approves about 90 percent of the new compounds without restrictions. Only a quarter of the 82,000 chemicals in use in the U.S. have ever been tested for toxicity.

Until recently, no one had even measured average levels of exposure among large numbers of Americans. No regulations required it, the tests are expensive, and technology sensitive enough to measure the tiniest levels didn't exist.

Last year the Centers for Disease Control and Prevention took a step toward closing that gap

Ruby Alcorn, three, inhales fire-retarding chemicals in dust from fabrics, furniture, and other home products—adding to the dose she took in as a breast-fed baby. Another class of chemicals, called phthalates, is added to plastics, including some food wraps (right), for pliability. Both can cause developmental problems in lab animals, even at relatively low doses.

when it released data on 148 substances, from DDT and other pesticides to metals, PCBs, and plastic ingredients, measured in the blood and urine of several thousand people. The study said little about health impacts on the people tested or how they might have encountered the chemicals. "The good news is that we are getting real data about exposure levels," says James Pirkle, the study's lead author. "This gives us a place to start."

I began my own chemical journey on an October morning at the Mount Sinai Hospital in New York City, where I gave urine and had blood drawn under the supervision of Leo Trasande. Trasande specializes in childhood exposures to mercury and other brain toxins. He had agreed to be one of several expert advisers on this project, which began as a Sinai phlebotomist extracted 14 vials of blood—so much that at vial 12 I felt woozy and went into a cold sweat. At vial 13 Trasande grabbed smelling salts, which hit my nostrils like a whiff of fire and allowed me to finish.

From New York my samples were shipped to Axys Analytical Services on Vancouver Island in Canada, one of a handful of state-of-the-art labs specializing in subtle chemical detection, analyzing everything from eagle eggs to human tissue for researchers and government agencies. A few weeks later, I followed my samples to

Want a formaldehyde hit? Apply the wrong cologne on a summer day. "Suddenly, there's chemistry going off all around your head," says University of Texas environmental engineer Richard Corsi. To test the "near-head environment," Corsi applies products similar to those shown and sticks his head in the box. Even natural fragrances can react with ozone in the air to make toxins.

OUR AUTHOR'S CHEMICAL REPORT CARD

What's inside David Ewing Duncan? To find out, he submitted to a huge battery of blood and urine tests to detect traces of industrial chemicals, dangerous metals, and pollutants he has picked up over a lifetime. As it turns out, Duncan can go toe-to-toe with a midwestern cornfield for pesticide variety—16 of the 28 tested for were found. Don't try to set him on fire either, as his blood is rich in BDE-47, a common fire retardant that is now being phased out. Does this make Duncan a freak of the chemical age? Hardly. In fact there may be nothing unusual about his chemical profile. Many of his results were no higher than the CDC mean levels for Americans. So what's in you?

320 CHEMICALS TESTED | **165** CHEMICALS DETECTED

PCBs
209 TESTED
97 DETECTED

PBDEs
40 TESTED
25 DETECTED

PESTICIDES
28 TESTED
16 DETECTED

DIOXINS
17 TESTED
10 DETECTED

PHTHALATES
7 TESTED
7 DETECTED

PFAs
13 TESTED
7 DETECTED

METALS
4 TESTED
3 DETECTED

BISPHENOLS
2 TESTED
0 DETECTED

RESULTS OF CONCERN

BDE-47 (Tetra)
Test Result: **249 ppb***
CDC Mean: **n/a**

HEALTH EFFECTS (SUSPECTED)
- thyroid
- neurodevelopmental

Now being phased out, this fire retardant is in many products and resists environmental degradation.

Dieldrin
Test Result: **5.11 ppb**
CDC Mean: **n/a**

HEALTH EFFECTS
- neurological
- kidney

A pesticide once used to kill termites and other soil insects, it still lingers in the environment.

p,p-DDE
Test Result: **256 ppb**
CDC Mean: **295 ppb**

HEALTH EFFECTS (SUSPECTED)
- reproductive
- liver

A breakdown product of DDT (now banned) that lingers in the body, it has health effects similar to those of the pesticide.

mMeP
Test Result: **34.8 ppb**
CDC Mean: **1.15 ppb**

HEALTH EFFECTS (SUSPECTED)
- reproductive

It's a member of a class called phthalates, used to thicken lotions and make plastics flexible.

Mercury
Test 1: **5 micrograms/liter**
Test 2: **12 micrograms/l**
CDC Poisoning Level: **10**

HEALTH EFFECTS
- neurological
- reproductive

Duncan's blood level of the toxic metal more than doubled after he ate two meals of swordfish and halibut.

*PARTS PER BILLION

PHOTO BY CATHERINE KARNOW

Canada to see how Axys teased out the tiny loads of compounds inside me.

I watched the specimens go through multiple stages of processing, which slowly separated sets of target chemicals from the thousands of other compounds, natural and unnatural, in my blood and urine. The extracts then went into a high-tech clean room containing mass spectrometers, sleek, freezer-size devices that work by flinging the components of a sample through a vacuum, down a long tube. Along the way, a magnetic field deflects the molecules, with lighter molecules swerving the most. The exact amount of deflection indicates each molecule's size and identity.

A few weeks later, Axys sent me my results—a grid of numbers in parts per billion or trillion—and I set out to learn, as best I could, where those toxic traces came from.

Some of them date back to my time in the womb, when my mother downloaded part of her own chemical burden through the placenta and the umbilical cord. More came after I was born, in her breast milk.

Once weaned, I began collecting my own chemicals as I grew up in northeastern Kansas, a few miles outside Kansas City. There I spent countless hot, muggy summer days playing in a dump near the Kansas River. Situated on a high limestone bluff above the fast brown water lined by cottonwoods and railroad tracks, the dump was a mother lode of old bottles, broken machines, steering wheels, and other items only boys can fully appreciate.

This was the late 1960s, and my friends and I had no way of knowing that this dump would later be declared an EPA superfund site, on the National Priority List for hazardous places. It turned out that for years, companies and individuals in this corner of Johnson County had dumped thousands of pounds of material contaminated with toxic chemicals here. "It was started as a landfill before there were any rules and regulations on how landfills were done," says Denise Jordan-Izaguirre, the regional representative for the federal Agency for Toxic Substances and Disease Registry. "There were metal tailings and heavy metals dumped in there. It was unfenced, unrestricted, so kids had access to it."

Kids like me.

Now capped, sealed, and closely monitored, the dump, called the Doepke-Holliday Site, also happens to be half a mile upriver from a county water intake that supplied drinking water for my family and 45,000 other households. "From what we can gather, there were contaminants going into the river," says Shelley Brodie, the EPA Remedial Project Manager for Doepke. In the 1960s, the county treated water drawn from the river, but not for all contaminants. Drinking water also came from 21 wells that tapped the aquifer near Doepke.

When I was a boy, my corner of Kansas was filthy, and the dump wasn't the only source of toxins. Industry lined the river a few miles away—factories making cars, soap, and fertilizers and other agricultural chemicals—and a power plant belched fumes. When we drove past the plants toward downtown Kansas City, we plunged into a noxious cloud that engulfed the car with smoke and an awful chemical stench. Flames rose from fertilizer plant stacks, burning off mustard-yellow plumes of sodium, and animal waste poured into the river. In the nearby farmland, trucks and crop dusters sprayed DDT and other pesticides in great, puffy clouds that we kids sometimes rode our bikes through, holding our breath and feeling very brave.

Today the air is clear, and the river free of effluents—a visible testament to the success of the U.S. environmental cleanup, spurred by the Clean Air and Clean Water Acts of the 1970s. But my Axys test results read like a chemical diary from 40 years ago. My blood contains traces of several chemicals now banned or restricted, including DDT (in the form of DDE, one of its breakdown products) and other pesticides such as the termite-killers chlordane and heptachlor. The levels are about what you would expect decades after exposure, says Rozman, the toxicologist at the University of Kansas Medical Center. My childhood playing in the dump, drinking the water, and breathing the polluted air could also explain some of the lead and dioxins in my blood, he says.

I went to college at a place and time that put me at the height of exposure for another set of substances found inside me—PCBs, once used as electrical insulators and heat-exchange fluids in transformers and other products. PCBs can lurk in the soil anywhere there's a dump or an old factory. But some of the largest releases took place along New York's Hudson River from the 1940s to the 1970s, when General Electric used PCBs at factories in the towns of Hudson Falls and Fort Edward. About 140 miles downstream is the city of Poughkeepsie, where I attended Vassar College in the late 1970s.

PCBs, oily liquids or solids, can persist in the environment for decades. In animals, they impair liver function, raise blood lipids, and cause cancers. Some of the 209 different PCBs chemically resemble dioxins and cause other mischief in lab animals: reproductive and nervous system damage, as well as developmental problems. By 1976, the toxicity of PCBs was unmistakable; the United States banned them, and GE stopped using them. But until then, GE legally dumped excess PCBs into the Hudson, which swept them all the way downriver to Poughkeepsie, one of eight cities that draw their drinking water from the Hudson.

In 1984, a 200-mile stretch of the Hudson, from Hudson Falls to New York City, was declared a superfund site, and plans to rid the river of PCBs were set in motion. GE has spent 300 million dollars on the cleanup so far, dredging up and disposing of PCBs in the river sediment under the supervision of the EPA. It is also working to stop the seepage of PCBs into the river from the factories.

Birds and other wildlife along the Hudson are thought to have suffered from the pollution, but its impact on humans is less definitive. One study in Hudson River communities found a 20 percent increase in the rate of hospitalization for respiratory diseases, while another, more reassuringly, found no increase in cancer deaths in the contaminated region. But among many of the locals, the fear is palpable.

"I grew up a block from the Fort Edward plant," says Dennis Prevost, a retired Army officer and public health advocate, who blames PCBs for the brain cancers that killed his brother at age 46 and a neighbor in her 20s. "The PCBs have migrated under the parking lot and into the community aquifer," which Prevost says was the source of Fort Edward's drinking water until municipal water replaced wells in 1984.

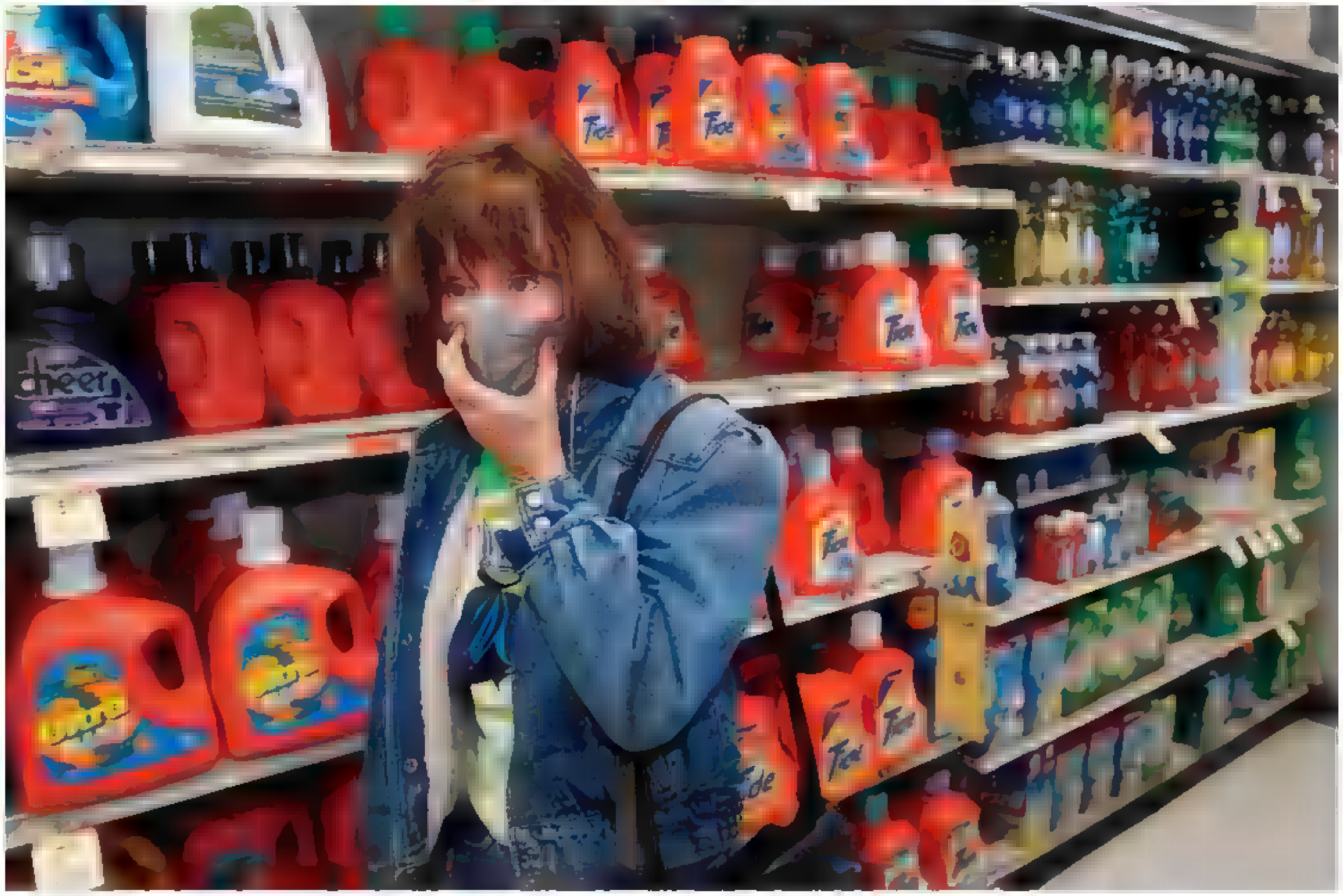
Ed Fitzgerald of the State University of New York at Albany, a former staff scientist at the state department of health, is conducting the most thorough study yet of the health effects of PCBs in the area. He says he has explained to Prevost and other residents that the risk from the wells was probably small because PCBs tend to settle to the bottom of an aquifer. Eating contaminated fish caught in the Hudson is a more likely exposure route, he says.

I didn't eat much Hudson River fish during my college days in the 1970s, but the drinking water in my dorm could have contained traces of the PCBs pouring into the river far upstream. That may be how I picked up my PCB body burden, which was about average for an American. Or maybe not. "PCBs are everywhere," says Leo Rosales, a local EPA official, "so who knows where you got it."

Back home in San Francisco, I encounter a newer generation of industrial chemicals—compounds that are not banned, and, like flame retardants, are increasing year by year in the environment and in my body. Sipping water after a workout, I could be exposing myself to bisphenol A, an ingredient in rigid plastics from water bottles to safety goggles. Bisphenol A causes reproductive system abnormalities in animals. My levels were so low they were undetectable—a rare moment of relief in my toxic odyssey.

And that faint lavender scent as I shampoo my hair? Credit it to phthalates, molecules that dissolve fragrances, thicken lotions, and add flexibility to PVC, vinyl, and some intravenous tubes in hospitals. The dashboards of most cars are loaded with phthalates, and so is some plastic food wrap. Heat and wear can release phthalate molecules, and humans swallow them or absorb them through the skin. Because they dissipate

A whiff of household products sends Betty Kreeger into fits of wheezing, nausea, and confusion. Like other people who say they suffer from multiple chemical sensitivity, she flees fragrances when she can and dons an air-filtering mask when she can't.



after a few minutes to a few hours in the body, most people's levels fluctuate during the day.

Like bisphenol A, phthalates disrupt reproductive development in mice. An expert panel convened by the National Toxicology Program recently concluded that although the evidence so far doesn't prove that phthalates pose any risk to people, it does raise "concern," especially about potential effects on infants. "We don't have the data in humans to know if the current levels are safe," says Antonia Calafat, a CDC phthalates expert. I scored higher than the mean in five out of seven phthalates tested. One of them, monomethyl phthalate, came in at 34.8 ppb, in the top 5 percent for Americans. Leo Trasande speculates that some of my phthalate levels were high because I gave my urine sample in the morning, just after I had showered and washed my hair.

My inventory of household chemicals also includes perfluorinated acids (PFAs)—tough, chemically resistant compounds that go into making nonstick and stain-resistant coatings. 3M also used them in its Scotchgard protector products until it found that the specific PFA compounds in Scotchgard were escaping into the environment and phased them out. In animals these chemicals damage the liver, affect thyroid hormones, and cause birth defects and perhaps cancer, but not much is known about their toxicity in humans.

Long-range pollution left its mark on my results as well: My blood contained low, probably harmless, levels of dioxins, which escape from paper mills, certain chemical plants, and incinerators. In the environment, dioxins settle on soil and in the water, then pass into the food chain. They build up in animal fat, and most people pick them up from meat and dairy products.

And then there is mercury, a neurotoxin that can permanently impair memory, learning centers, and behavior. Coal-burning power plants are a major source of mercury, sending it out their stacks into the atmosphere, where it disperses in the wind, falls in rain, and eventually washes into lakes, streams, or oceans. There bacteria transform it into a compound called methylmercury, which moves up the food chain after plankton absorb it from the water and are

When Christine Larson was six months old, her blood lead was over twice the level the government says is safe; even lower levels can reduce IQ, stunt growth, and cause behavior problems. The vintage Cleveland-area house her parents had recently bought had lead paint, illegal for residential use since 1978. The lead sources are now gone, and Christine is "smart as ■ whip," her mother says.

eaten by small fish. Large predatory fish at the top of the marine food chain, like tuna and swordfish, accumulate the highest concentrations of methylmercury—and pass it on to seafood lovers.

For people in northern California, mercury exposure is also a legacy of the gold rush 150 years ago, when miners used quicksilver, or liquid mercury, to separate the gold from other ores in the hodgepodge of mines in the Sierra Nevada. Over the decades, streams and groundwater washed mercury-laden sediment out of the old mine tailings and swept it into San Francisco Bay.

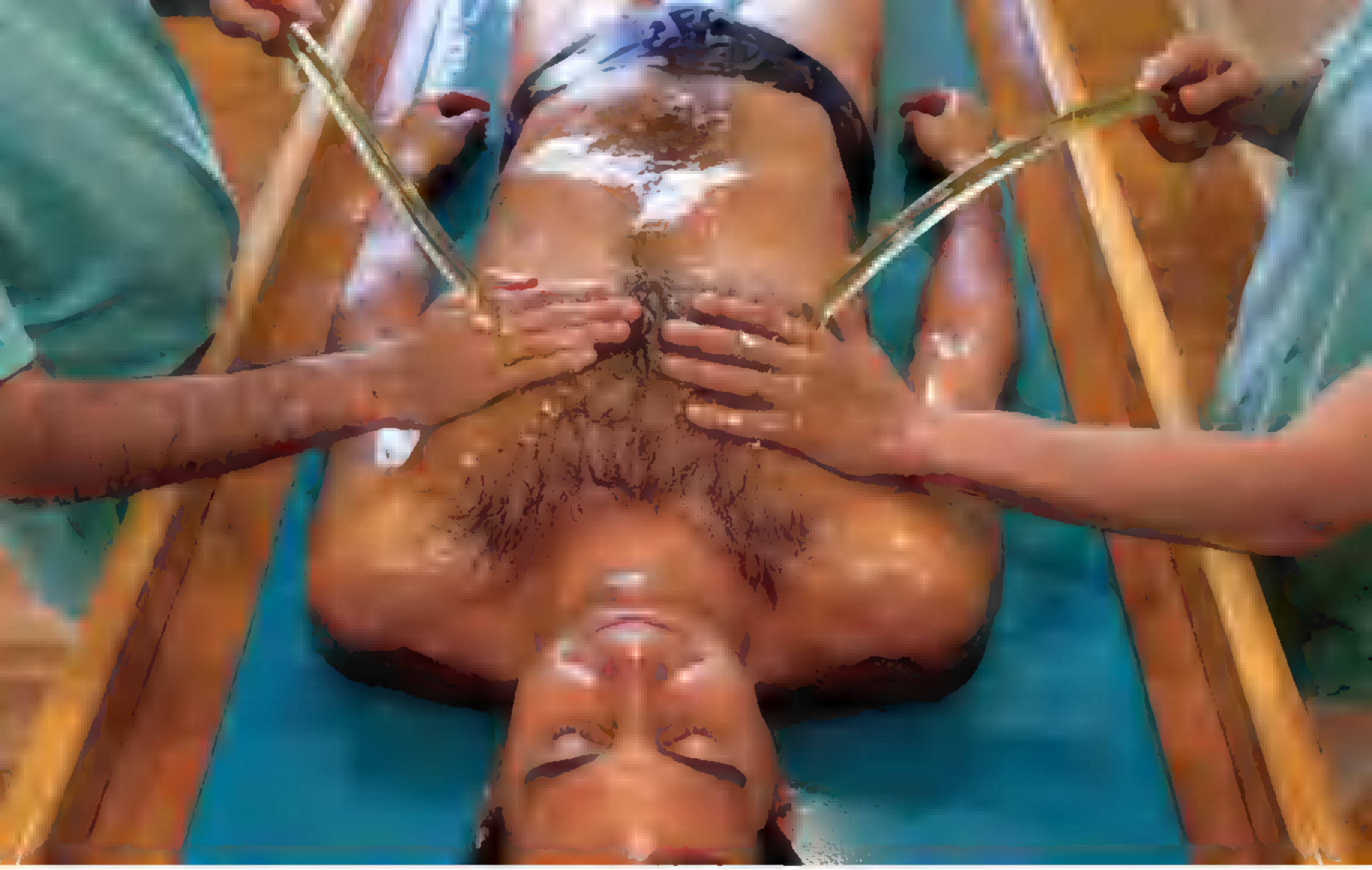
I don't eat much fish, and the levels of mercury in my blood were modest. But I wondered what would happen if I gorged on large fish for a meal or two. So one afternoon I bought some halibut and swordfish at a fish market in the old Ferry Building on San Francisco Bay. Both were caught in the ocean just outside the Golden Gate, where they might have picked up mercury from the old mines. That night I ate the halibut with basil and a dash of soy sauce; I downed the swordfish for breakfast with eggs (cooked in my nonstick pan).

Twenty-four hours later I had my blood drawn and retested. My level of mercury had more than doubled, from 5 micrograms per liter to a higher-than-recommended 12. Mercury at 70 or 80 micrograms per liter is dangerous for adults, says Leo Trasande, and much lower levels can affect children. "Children have suffered losses in IQ at 5.8 micrograms." He advises me to avoid repeating the gorge experiment.

It's a lot harder to dodge the PBDE flame retardants responsible for the most worrisome of my test results. My world—and yours—has become saturated with them since they were introduced about 30 years ago.

Scientists have found the compounds planetwide, in polar bears in the Arctic, cormorants in England, and killer whales in the Pacific. Bergman, the Swedish chemist, and his colleagues first called attention to potential health risks in 1998 when they reported an alarming increase in PBDEs in human breast milk, from none in milk preserved in 1972 to an average of four ppb in 1997.

The compounds escape from treated plastic and fabrics in dust particles or as gases that cling to dust. People inhale the dust; infants crawling



At ■ spa in Maharishi Vedic City, Iowa, John Moore (above) hopes to speed the elimination of PCBs, which are stored in fat for years. Technicians ply him with oils in a purification process based on Indian ayurveda tradition. At a Marin County, California, mall (right) teens in the Campaign for Safe Cosmetics show off makeup free of chemicals linked to cancer and birth defects in animals.

on the floor get an especially high dose. Bergman describes a family, tested in Oakland, California, by the *Oakland Tribune*, whose two small children had blood levels even higher than mine. When he and his colleagues summed up the test results for six different PBDEs, they found total levels of 390 ppb in the five-year-old girl and 650 ppb—twice my total—in the 18-month-old boy.

In 2001, researchers in Sweden fed young mice a PBDE mixture similar to one used in furniture and found that they did poorly on tests of learning, memory, and behavior. Last year, scientists at Berlin's Charité University Medical School reported that pregnant female rats with PBDE levels no higher than mine gave birth to male pups with impaired reproductive health.

Linda Birnbaum, an EPA expert on these flame retardants, says that researchers will have to identify many more people with high PBDE exposures, like the Oakland family and me, before they will be able to detect any human effects. Bergman says that in a pregnant woman my levels would be of concern. "Any level above a hundred parts per billion is a risk to newborns," he guesses. No one knows for sure.

Any margin of safety may be narrowing. In a review of several studies, Ronald Hites of Indiana University found an exponential rise in people and animals, with the levels doubling every three to five years. Now the CDC is putting a

comprehensive study of PBDE levels in the U.S. on a fast track, with results due out late this year. Pirkle, who is running the study, says my seemingly extreme levels may no longer be out of the ordinary. "We'll let you know," he says.

Given the stakes, why take a chance on these chemicals? Why not immediately ban them? In 2004, Europe did just that for the penta- and octa-BDEs, which animal tests suggest are the most toxic of the compounds. California will also ban these forms by 2008, and in 2004 Chemtura, an Indiana company that is the only U.S. maker of pentas and octas, agreed to phase them out. Currently, there are no plans to ban the much more prevalent deca-BDEs. They reportedly break down more quickly in the environment and in people, although their breakdown products may include the same old pentas and octas.

Nor is it clear that banning a suspect chemical is always the best option. Flaming beds and airplane seats are not an inviting prospect either. The University of Surrey in England recently assessed the risks and benefits of flame retardants in consumer products. The report concluded: "The benefits of many flame retardants in reducing the risk from fire outweigh the risks to human health."

Except for some pollutants, after all, every industrial chemical was created for a purpose. Even DDT, the archvillain of Rachel Carson's 1962 classic book *Silent Spring*, which launched the modern environmental movement, was once hailed as a miracle substance because it killed the mosquitoes that carry malaria, yellow fever, and other scourges. It saved countless lives before it was banned in much of the world because of its toxicity to wildlife. "Chemicals are not all bad," says Scott Phillips, a medical toxicologist in Denver. "While we have seen some cancer rates rise," he says, "we also have seen a doubling of the human life span in the past century."

The key is knowing more about these substances, so we are not blindsided by unexpected hazards, says California State Senator Deborah Ortiz, chair of the Senate Health Committee and the author of a bill to monitor chemical exposure. "We benefit from these chemicals, but there are consequences, and we need to understand these consequences much better than we do now." Sarah Brozena of the industry-supported American Chemistry Council thinks safeguards are adequate now, but she concedes: "That's not to say this process was done right in the past."

The European Union last year gave initial approval to a measure called REACH—Registration, Evaluation, and Authorization of Chemicals—which would require companies to prove the substances they market or use are safe, or that the benefits outweigh any risks. The bill, which the chemical industry and the U.S. government oppose, would also encourage companies to find safer alternatives to suspect flame retardants, pesticides, solvents, and other chemicals. That would give a boost to the so-called green chemistry movement, a search for alternatives that is already under way in laboratories on both sides of the Atlantic.

As unsettling as my journey down chemical lane was, it left out thousands of compounds, among them pesticides, plastics, solvents, and a rocket-fuel ingredient called perchlorate that is polluting groundwater in many regions of the country. Nor was I tested for chemical cocktails—mixtures of chemicals that may do little harm on their own but act together to damage human cells. Mixed together, pesticides, PCBs, phthalates, and others "might have additive effects, or they might be antagonistic," says James Pirkle of the CDC, "or they may do nothing. We don't know."

Soon after I receive my results, I show them to my internist, who admits that he too knows little about these chemicals, other than lead and mercury. But he confirms that I am healthy, as far as he can tell. He tells me not to worry. So I'll keep flying, and scrambling my eggs on Teflon, and using that scented shampoo. But I'll never feel quite the same about the chemicals that make life better in so many ways.

Home, Sick Home Learn about the toxins we encounter every day in an interactive graphic, and explore related links at **ngm.com/0610**.

OUR TOXIC HOMES

We can't run home to escape chemicals that infiltrate our bodies. Our dwellings are rife with them—some clearly toxic, others only suspected of being harmful.

PBDEs

They stop fires but stay around in people

Polybrominated diphenyl ethers (PBDEs), used as flame retardants, are building up rapidly in people's bodies. They cause developmental problems in lab animals. The most worrisome of these compounds are being phased out, but the PBDE variety still used in the U.S. may also be harmful.

HOW TO AVOID

PBDEs are found in many appliances and some fabrics, and are unavoidable.

PHTHALATES

The chemical additive for all seasons

These chemicals have a huge array of uses, from making vinyl flexible to giving lotions the right consistency. In lab animals, they have caused problems in the sexual development of males, and some recent human studies suggest that the same things might be happening to baby boys.

HOW TO AVOID

A few cosmetics companies have made a point of shunning them, but there are myriad sources of exposure.

PESTICIDES

They're harming more than just the bugs

Some, like DDT, have been banned, while others, such as atrazine, are restricted. But the list of those still commonly in use for killing everything from household roaches to exotic crop fungi is long, and researchers have linked some to asthma and neurological, developmental, and immunological problems.

HOW TO AVOID

Wash produce well, or buy organic. In agricultural areas, limit buildup at home by frequent vacuuming.

PFAs

Convenient but maybe carcinogenic

Used in scratch- and stain-resistant coatings, they take years for the body to eliminate. The 3M Corporation phased them out after one type, perfluorooctane sulfonate (PFOS), an ingredient in Scotchgard, was found to pervade the global environment. Another type, perfluorooctane acid (PFOA), is still used in fabrics and to make nonstick pans, and high doses may cause cancer in animals.

HOW TO AVOID

Found in air, water, and food, they are unavoidable.

BEDROOM / BATHROOM

- **PBDEs** Foam mattress and pillows, carpet and carpet padding, chair cushions, hair dryer, telephone
- **PESTICIDES** Antimicrobial soap, pet flea collar, flowers from garden
- **METALS** Lead paint
- **PHTHALATES** Shower curtain, nail polish, shampoo, perfume, deodorants, lotion, soap, hair spray, medicines, vinyl flooring, toothpaste, plastic bath toys

LIVING ROOM

- **PBDEs** Couch cushions, chair cushions, electronics (TV, computer), carpets and carpet padding, electronic games, pet bed
- **BISPHENOLS** Plastic baby bottle
- **PHTHALATES** Extension cords, vinyl wallpaper and blinds
- **PESTICIDES** Tracked indoors, drifting in window, on pet flea collar
- **PFAs** Furniture fabric, microwave popcorn bag

PCBs

Long banned, they are still around

Polychlorinated biphenyls (PCBs) were wonder substances. Hard to set aflame, they were common coolants and insulators in electrical systems. Their durability has a dark side: They are slow to break down in the environment, and they build up in animal and human tissues. The effects include liver damage and cancer in lab animals.

HOW TO AVOID

Now banned, they remain pervasive. Avoid eating fish or game from areas known to be contaminated.

DIOXINS

Industrial by-product, presidential poison

Similar in toxicity to PCBs, dioxins result from industrial activities and fires. They enter the food chain in contaminated areas and build up in plant and animal fats. Deliberately tainted soup may have been the vehicle used to poison Ukrainian President Victor Yushchenko, leaving his face disfigured. Cancer and birth defects are among other likely dioxin effects.

HOW TO AVOID

Avoid fatty meats and areas known to be contaminated.

BISPHENOLS

Hormones in your water bottle

Polycarbonate plastics, found in some rigid plastic bottles, are made with bisphenol A, a synthetic estrogen that may leach into liquid over time as the plastic degrades. Researchers have found evidence in lab animals that these estrogen mimics may cause reproductive harm to male and female fetuses.

TO AVOID

Avoid hard plastic bottles. That may not eliminate all risk if, as some research suggests, background levels are now high enough to be harmful.

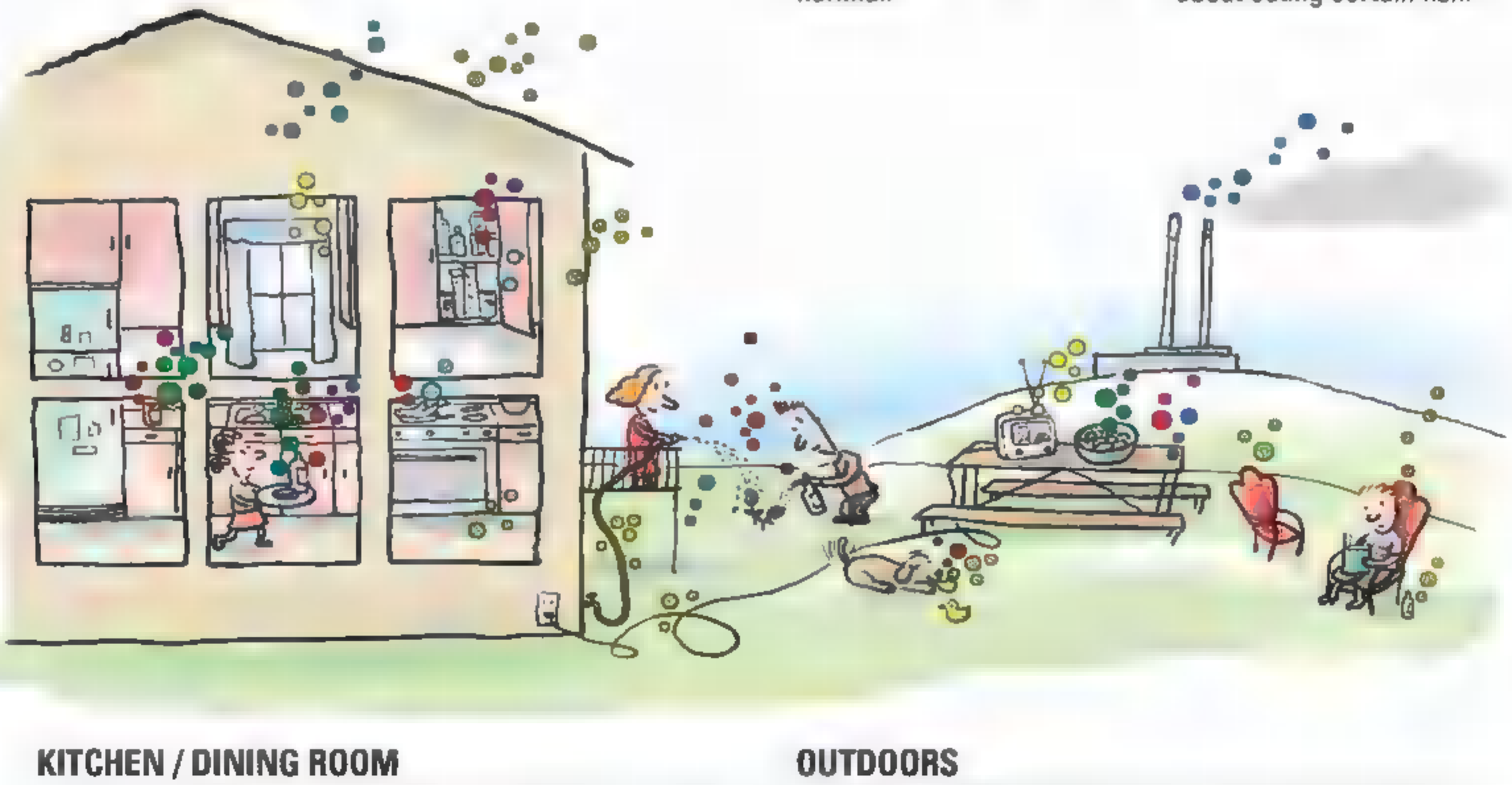
METALS

Deadly poisons hiding in plain sight

Toxic metals are some of the most common industrial poisons in the home. Old paint contains lead, fish like tuna contain mercury, and your pressure-treated deck can expose your family to arsenic and chromium. The effects on young children can be profound, ranging from subtle developmental delays to death.

HOW TO AVOID

Remove or seal up old paint and pressure-treated lumber. Pregnant women and children should be cautious about eating certain fish.



KITCHEN / DINING ROOM

- **PHTHALATES** Plastic containers and bottles, some food wraps, vinyl flooring
- **DIOXINS** Fatty meats, dairy products, fish
- **PCBs** Contaminated fish and game
- **METALS** Mercury-contaminated fish
- **BISPHENOLS** Plastic containers, lining of food cans
- **PFAs** Nonstick pans
- **PBDEs** Coffeemaker, blender, microwave, toaster

OUTDOORS

- **METALS** Pressure-treated wood table (arsenic and chromium), power plant emissions (mercury), lead paint
- **PESTICIDES** Lawn, garden, and pet flea collar
- **DIOXINS** Fatty meats and fish
- **PHTHALATES** Water bottles, lawn furniture, garden hose, vinyl toys, roof membrane with PVC, outdoor extension cord with PVC
- **PBDEs** TV, boombox
- **PCBs** Fatty meats

ART BY BONNIE TIMMONS


More than the roar of motorbikes fills the air in Ho Chi Minh City, Vietnam,
are now a majority. There's also acrid smoke, rich in
polycyclic aromatic hydrocarbons (PAHs) chemically
burned fuel that's lab animals.

For most of us, environmental chemicals come in tiny doses, and any harm is hard to discern. But accidents and contaminated hot spots can deluge people with toxins. The effects are anything but subtle.

A **Tiny residues of pesticide in food are no more than a nagging worry for consumers.** But for banana plantation workers in Central America during the 1970s and 1980s, pesticide exposure had devastating consequences. A chemical called DBCP, used to control rootworms, left as many as 30,000 men sterile for life.

This is the dark side of industrial chemistry, which gives us convenient products and abundant food but exacts a human cost. The cost is never more apparent than when accidents or chemical "hot spots" expose people to pesticides, heavy metals, and other substances at levels many times higher than most of us experience. The victims are often the world's poor and powerless—people who live close to the smokestacks and dumps and work in the riskiest jobs. Tragic in themselves, these high exposures also raise troubling questions about the much smaller, parts-per-billion traces we all pick up in daily life ("The Pollution Within," page 116).

One way scientists find out whether or not these chemical traces are dangerous is to give high doses to animals, looking for threshold levels at which signs of toxicity appear and trying to understand the nature of the damage. But extreme human exposures also provide clues. "These tragedies provide us with information that comes from people," says John Osterloh of the National Center for Environmental Health at the U.S. Centers for Disease Control.

Wake-up calls about the dangers of methylmercury, the form of mercury found in water and seafood, came decades ago from accidents and hot spot exposures. In a notorious case from the 1950s, 68 people living on Japan's Minamata Bay died and hundreds suffered brain damage

A young girl lies helpless in a Ho Chi Minh City facility for disabled children, many thought to be victims of the dioxin-containing defoliant Agent Orange, with which the U.S. sprayed large areas of Vietnam. She was diagnosed with Fraser syndrome, a genetic disorder marked by deformities including fused eyelids and digits. It can't be definitely linked to dioxin, but the Vietnamese are convinced.

This is the dark side of industrial chemistry. The victims are often the world's poor and powerless—people who live close to the smokestacks and dumps and work in the riskiest jobs.

after eating fish contaminated with mercury dumped by a nearby chemical plant. In 1971-72, at least 459 people died and 6,500 were hospitalized in Iraq during a famine, when they ate bread made from seed grain that had been treated with a methylmercury-containing fungicide to hold down mold growth. The seeds were safe to plant, but not to eat. In Denmark's Faroe Islands, where people eat whale meat and fish containing high levels of mercury, studies of the cognitive development of children born to mercury-exposed women helped other countries set standards for safe levels of mercury.

Tragedy has also provided graphic evidence of the dangers of dioxin, a pollutant emitted by burning wood and trash and generated by chemical plants. During the Vietnam War, U.S. forces sprayed millions of acres of jungle with Agent Orange, which stripped foliage from trees. The spray was tainted with dioxin, a by-product of the manufacturing process. Over the years, people living in the defoliated areas and soldiers who applied the Agent Orange or marched through afterward have developed cancer and diabetes in unusual numbers. In 1976, a tank exploded in a chemical factory in Seveso, Italy, releasing a cloud of dioxin that led to a long-term increase in cancer among the 37,000 people exposed. These disasters helped prompt measures that reduced dioxin emissions from U.S. and European factories by more than half.

Related to dioxins are PCBs, once so widely used as coolants and electrical insulators that the U.S. was producing 85 million pounds a year in the mid-1970s. By then, however, the warning signs were hard to ignore. In 1968 thousands of people on the island of Kyushu, Japan, had eaten rice oil contaminated with PCBs during manufacture. Nearly 1,800 fell ill, and 112 died of acute poisoning, cancer, and other ailments. Children born to the victims had immune system and developmental problems. News of the disaster and a drumbeat of reports about PCB contamination of water, food, and wildlife alarmed the public, and the U.S. banned the compounds in 1976.

Toxic exposures aren't always due to accidents or ignorance about a chemical's true dangers. The U.S. banned widespread use of DBCP as a pesticide in 1977, although traces still linger in groundwater in some parts of the country. Yet banana workers have filed lawsuits contending that growers in Central America continued to apply it for years. Today, workers there still spray toxic pesticides without protective clothing or masks.

In Central American countries, 7,000 cases of acute pesticide poisoning are reported each year; in 1990 the World Health Organization estimated the number of cases worldwide at three million. Symptoms include head pains, dizziness, faintness, burns, eye inflammation, and respiratory problems. Workers in the developing world continue to be exposed to chemicals banned in the U.S. and Europe, and to toxic waste and pollution at levels unacceptable in the developed world.

For newer chemicals, such as the phthalates found in cosmetics and plastics and the flame retardants in fabrics and electronics, headline-grabbing accidents and worker poisonings are rare—perhaps because safety measures have improved, or because the chemicals are not as acutely toxic as older compounds. Whether they are less harmful in the long run is not clear.

Scott Phillips, a medical toxicologist in Denver, cautions against comparing the effects of high doses with the smidgens inside us. "Any substance, even seemingly harmless ones, can be dangerous in certain quantities and under the right circumstances," he says. Leo Trasande, a toxicologist at Mount Sinai Hospital in New York City, thinks it can be equally risky to ignore the lessons from high exposures. "The extreme cases show us what can happen," he says.

While science searches for answers, one thing is certain: The known horrors inflicted by high doses of chemicals make the small amounts inside each of us even more unsettling.

—David Ewing Duncan

To raise tobacco fit for export cigars, workers at a Nicaragua farm (above) wade through clouds of pesticide. A few days after falling ill from fumes, sprayer Medardo Bellorini (below, washing off chemicals after work) was back in the fields. Pesticides have been linked to cancer and endocrine and nervous system disorders.

A rustic brick kiln in San Luis Potosi, Mexico (left), belches black smoke at brickmakers, who sustain invisible damage with each day of work. The smoke is rich in PAHs from incompletely burned wood and oil used to heat the furnace. Scientists have documented DNA damage in some children at the site, likely caused by toxic exposure.

Along with pollution from decades of PCB production in their city, Anniston, Alabama, residents learned in recent years of another hazard: a project to incinerate decommissioned chemical weapons at a nearby military depot. Sha-Nekia Pittman and her daughter, Tikyia Jackson (above), practice donning government-issued gas hoods, their sole defense against ■ leak. □

Unearthing the bones of human and animal sacrifices, archaeologists probe the mysteries of Mexico's

PYRAMID OF DEATH

Sacred symbols of supernatural power, golden eagles [illegible] the [illegible] of a dozen men killed in a horrifying ritual [illegible] witnessed by a crowd of thousands at the great urban center of Teotihuacán in about A.D. 300

BY A. R. WILLIAMS • PHOTOGRAPHS BY JESÚS EDUARDO LÓPEZ REYES
NATIONAL GEOGRAPHIC SENIOR WRITER

Even the ferocious Aztec were awed by their first glimpse of Teotihuacan. By the 13th century when the Aztec swept into central Mexico, the once teeming city—which reached its zenith around A.D. 400—had been long since abandoned by its mysterious builders. Its grand ceremonial center, where tens of thousands of people had gathered amid sacred monuments of stone, lay under thick green overgrowth. The Aztec gave the site its name and identified its most imposing features according to their own beliefs—the Pyramid of the Sun and Pyramid of the Moon. Assuming that some of the buildings were tombs, they called the main thoroughfare Street of the Dead.

They were, as it turns out, uncannily accurate. Burials both rich and gruesome have recently been discovered in the Pyramid of the Moon during excavations headed by Rubén Cabrera Castro, of Mexico's National Institute of Anthropology and History, and Saburo Sugiyama, of Japan's Aichi Prefectural University. Tunneling deep into the 140-foot-tall stone structure, the archaeologists located five burial sites. After most of the dirt and debris had been dug out, each site was reinforced with steel beams for safety. Supplied with fresh air pumped in from the outside, the archaeologists scraped the last layers of earth from the floor to reveal scenes of carnage: disembodied heads and the remains

Society Grant This Research Committee project was supported by your Society membership.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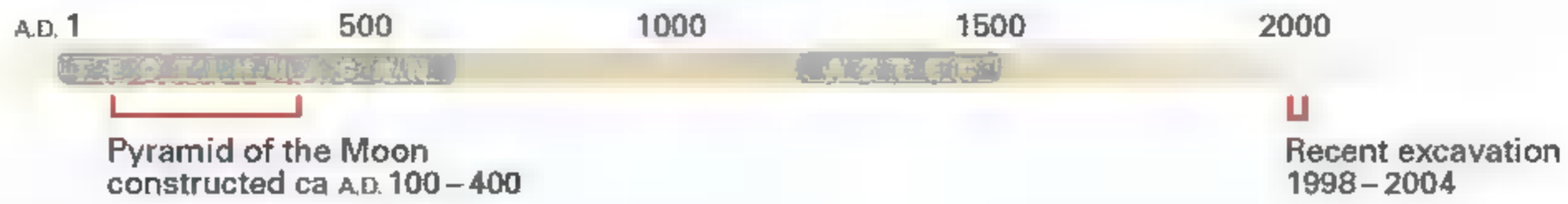


of foreign warriors and dignitaries, carnivorous mammals, birds of prey, and deadly reptiles.

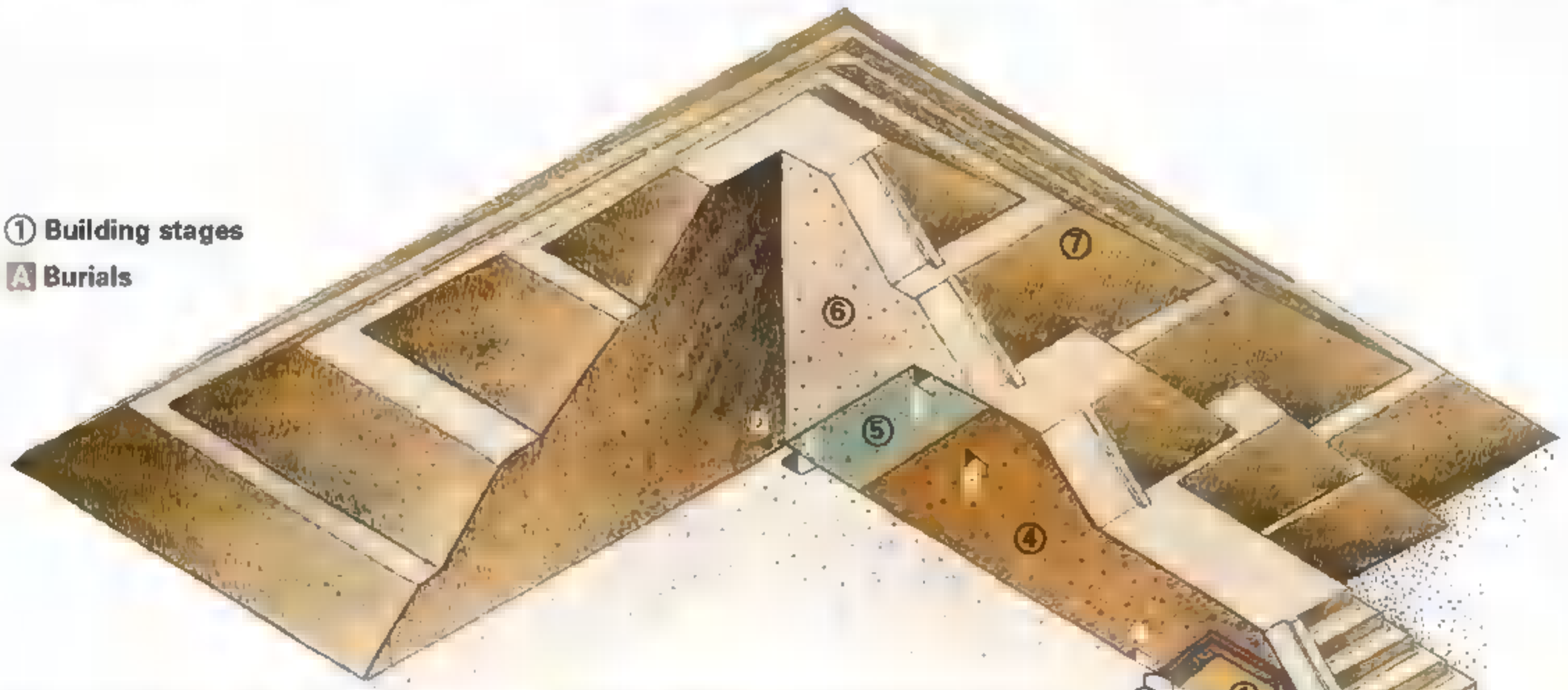
Evidence indicates that all the victims were ritually killed to consecrate successive stages of the pyramid's construction (illustration below). The earliest sacrifice, from about A.D. 200, marked a substantial enlargement of the building. A wounded foreigner, most likely a prisoner of war, was apparently buried alive with his hands tied behind him (opposite). Animals representing mythical powers and military might surrounded him—pumas, a wolf, eagles, a falcon, an owl, and rattlesnakes—some buried alive in cages. Finely crafted offerings included weapons of obsidian and a figurine of solid greenstone, perhaps a war goddess to whom the burial was dedicated. Each subsequent burial was different, but all had the same aim: "Human sacrifice was important to control the people," says Sugiyama, "to convince them to do what their rulers wanted."

Teotihuacan was one of the first true urban centers in the Western Hemisphere, covering nearly eight square miles at its heyday. Precious artifacts recovered from the Pyramid of the Moon and other structures reveal that this was ■ wealthy trade metropolis with far-reaching connections. Inexplicably, the city suffered sudden and violent collapse in about A.D. 600 and much of the population fled. They left few written records, just the ruins of their city and intriguing clues about a once powerful culture.

Remains of twelve victims, their arms still bound with rope, were found in Burial B. Ten had been decapitated.

The heads of fourteen wolves and four pumas were unearthed in Burial C, along with the skeletons of four men.

Burial E held three foreigners of high status, all interred in ■ sitting position and laden with jewelry.



Begun about A.D. 100, the Pyramid of the Moon was built in seven stages, each topping the previous one. Three stages (4, 5, and 6), dating from about 200 to 350, were dedicated with gruesome sacrifices. The earliest burial (A) included a human victim and several animals—all apparently buried alive (opposite).

ART BY JACK UNRUH

DEAD MEN TELL TALES

Two mass graves half a century apart convey the same message: Teotihuacan's military dominated portions of Mesoamerica with brutal force. Beneath excavation co-director Saburo Sugiyama (above) lie the remains of ten men from about A.D. 300. Probably prisoners of war, they were made eternally submissive: With their hands tied behind them and stripped of all ornamentation, they were beheaded and thrown in a heap. The skulls of 17 men were unearthed in a later grave (right). All of the victims were foreigners, as indicated by bone analysis and teeth inlaid with greenstone and pyrite.

Discoveries from the burial of A.D. 300 add up to a puzzle. A unique mosaic figurine of greenstone (right) was likely a ritual object. A puma (top) was one of more than 40 sacrificial animals, most found with their legs bound. Scattered beads fill the mouth of a human sacrifice (above). "These offerings are like sentences," says archaeologist Leonardo López Luján, "but we don't have all the words, and we don't completely understand their sequence, so they're hard to read." Continuing work at Teotihuacan may fill in some of the gaps in surprising—and terrible—ways. □

Go Deeper See more images from inside the Pyramid of the Moon and learn how archaeologists piece together a skeleton's past at **ngm.com/0610.**

Parks in Crisis

Ever shrinking budgets mean shorter hours of operation, higher admission fees, and fewer full-time employees to provide crucial maintenance and educational services within national parks.

What You Can Do "Concerned citizens must take a stand against allowing the system to deteriorate," says Bill Wade, chairman of the executive council of the Coalition of National Park Service Retirees—and a former superintendent of Shenandoah National Park. People should let their government representatives know that public lands are a priority, he insists, and support nonprofit organizations that support the national parks and other wild lands, including:

- **National Parks Conservation Association** advocates for national parks and for the National Park Service. *npca.org*
- **Natural Resources Defense Council** has pinpointed a dozen "BioGems"—extraordinary wild places worth saving. *nrdc.org*
- **Sierra Club's** "Take Action" program sends letters on environmental issues to members of Congress. *sierraclub.org*
- **Wilderness Society** has worked for wild places since 1935. Particular concerns include preservation of wild lands from oil development and protection of roadless regions. *wilderness.org*
- **U.S. National Park Service** administers national parks, historic sites, memorials, monuments, and more. Last year 137,000 volunteers donated some five million hours through the NPS Volunteers-in-Parks program. *nps.gov/volunteer*

Problems in the Parks

Everglades Fertilizer pollution, urban encroachment, and falling water levels make this the only U.S. park on the World Heritage Danger List.

Great Smoky Mountains This park, which straddles the border of North Carolina and Tennessee, has the most polluted air of all U.S. parks.

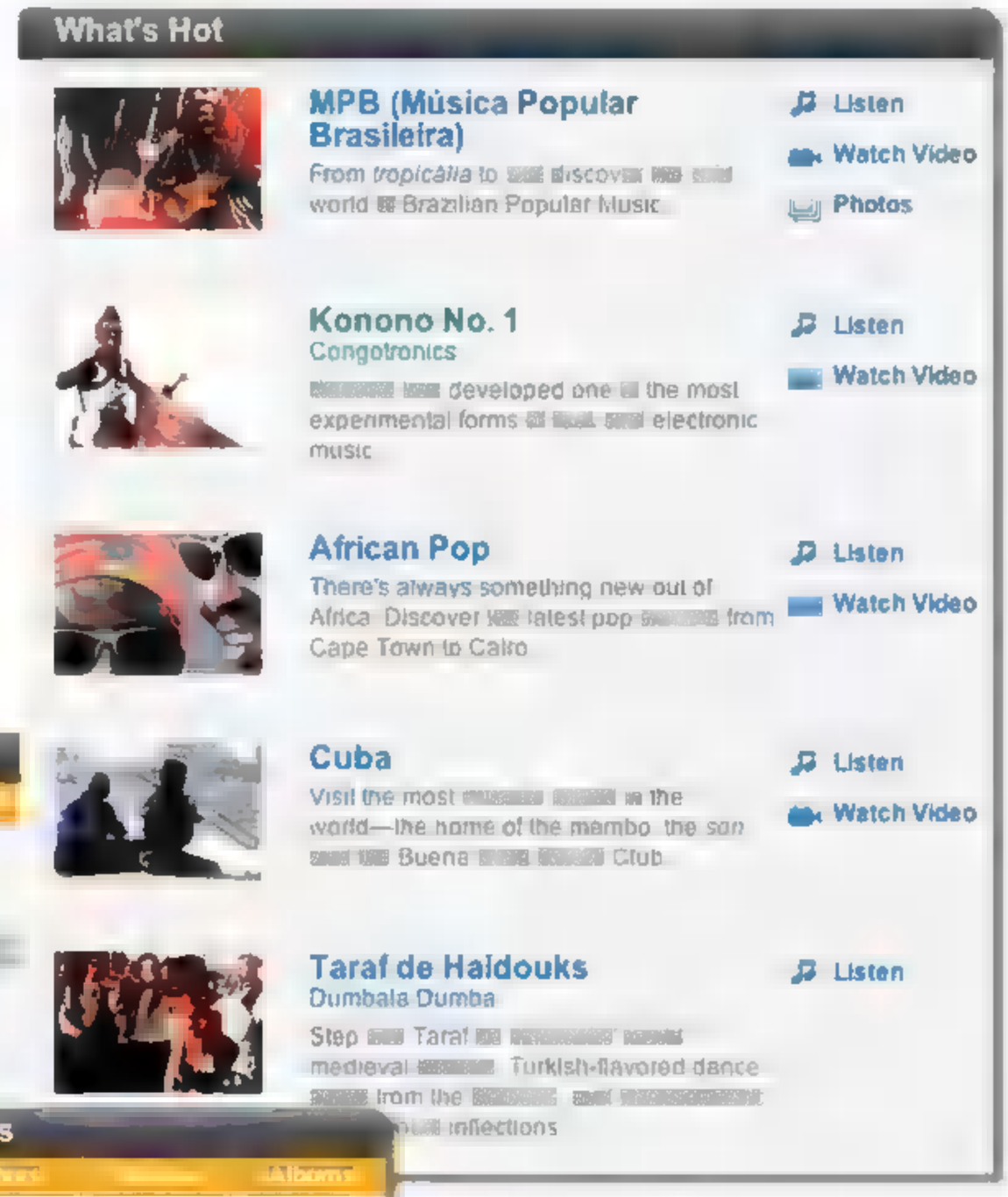
Virgin Islands National Park Elevated water temperatures in 2005 caused unprecedented coral bleaching and die-off.

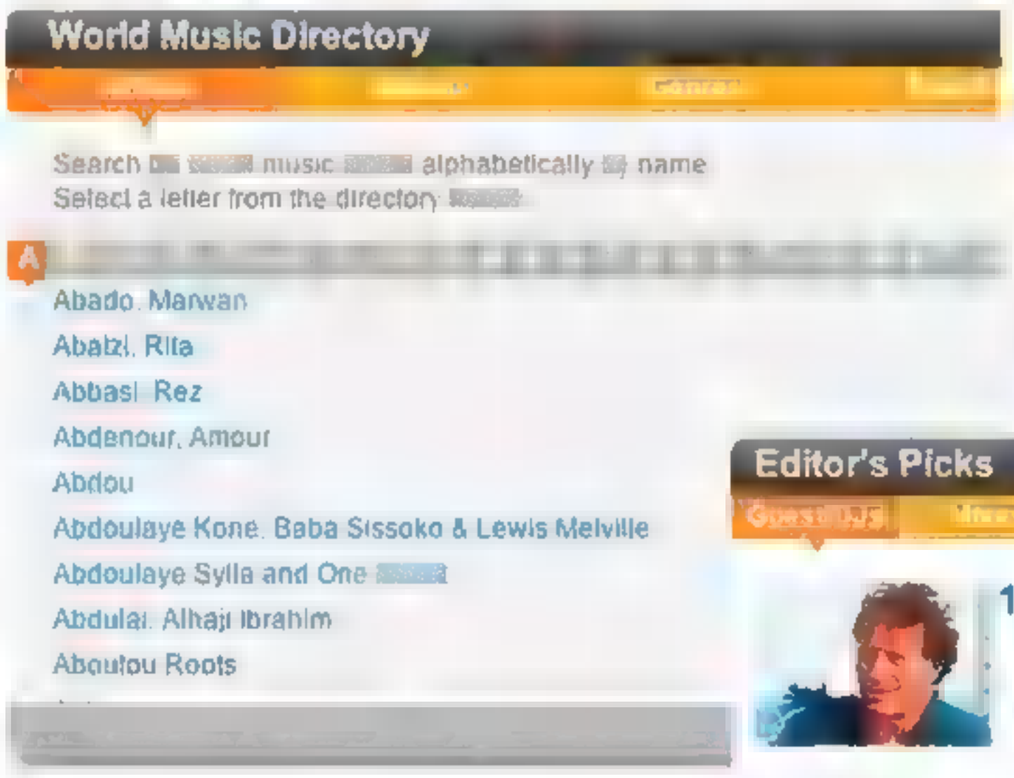
Shenandoah Streams in the Virginia park—and animals living there—are proving vulnerable to acid rain.

Grand Canyon Views are often obscured by ■ sulfur dioxide haze drifting in from outside the Arizona park.

PHOTO: MICHAEL MELFORD

World Music



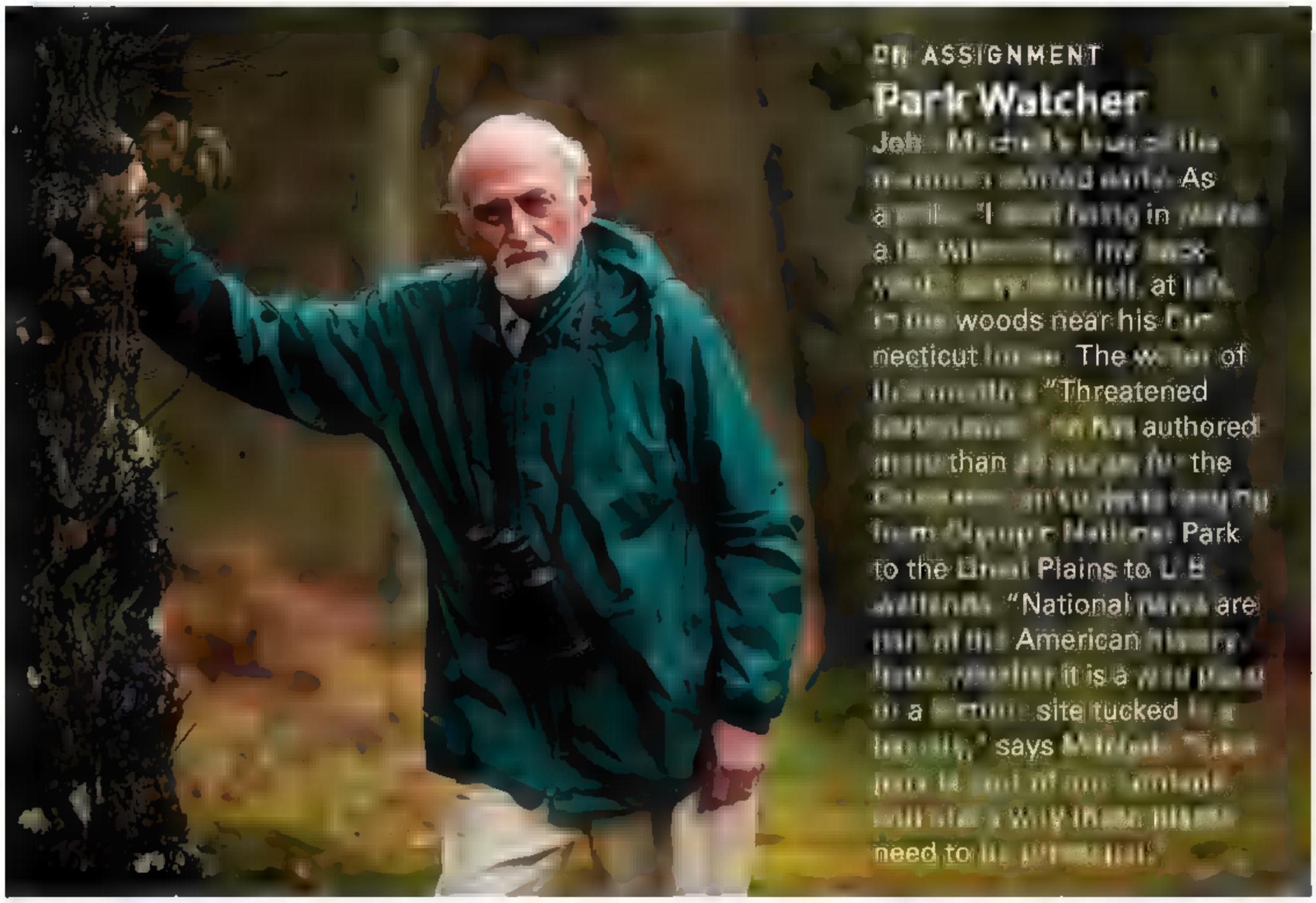


Browse songs by nation, artist, and genre. See what's popular with other listeners and watch videos at *worldmusic.nationalgeographic.com*.

NG ONLINE **World Music** Whether it's Celtic-infused African pop or picked-fiddle Mongolian folk, music can transcend borders, class, and language. At the Society's new World Music website, *worldmusic.nationalgeographic.com,* the tunes can even teach a little geography. "National Geographic brings a window to the world," says David Beal, record producer, former drummer for Joe Cocker, and the man behind the World Music project. "But our goal is to make it a doorway to the world." World Music offers border-crossing genres such as Israeli reggae and Thai country available for downloading. The site also provides videos, artist interviews, and information about traditional and popular music in different countries. The emergence of this music on the Web is "a chance for world music," according to Baaba Maal, a singer from Senegal whose songs are also featured on the site. Global music only needed a proving ground, he says. "Now it's coming."

Baaba Maal performs in London.

PHOTO: ADRIAN BOOT, URBANIMAGE



October Contributors

John G. Mitchell interviewed George Schaller for "Voices" (page 32) and wrote "Threatened Sanctuaries" (page 88). He was a GEOGRAPHIC staff writer and editor from 1994 until 2003.

David Quammen wrote "An Endangered Idea" (page 62). He has won three National Magazine Awards, including one for his November 2004 NATIONAL GEOGRAPHIC cover story on Darwin.

Michael Melford visited 16 parks for "Our National Parks in Peril" (page 68). His photos of Great Smoky Mountains National Park appeared in the August 2006 GEOGRAPHIC.

Lynne Warren, ■ staff writer at the GEOGRAPHIC, wrote "A Report Card" (page 70).

Amy Toensing started as a photography intern at NATIONAL GEOGRAPHIC. "Urban Downtime" (page 98) is her eighth story for the magazine.

Jennifer Ackerman wrote "City Parks: Space for the Soul" (page 110). Her latest book, to be published next year, explores what happens within the human body during a 24-hour period.

David Ewing Duncan wrote "The Pollution Within" (page 116). He co-hosts National Public Radio's *BioTech Nation* and is the author of numerous books, including *Masterminds: Genius, DNA, and the Quest to Rewrite Life.*

Peter Essick, ■ frequent contributor, photographed "The Pollution Within."

Jesús Eduardo López Reyes photographed "Pyramid of Death" (page 144). A freelance photographer who lives in Mexico City, he has worked with the GEOGRAPHIC for 18 years.

A. R. Williams, a senior writer at the magazine, is ■ former archaeologist. She wrote "Pyramid of Death."

Tales From the Field Learn more about our contributors in Features at **ngm.com/0610.**

PHOTO: MICHAEL MELFORD

INSIDE GEOGRAPHIC

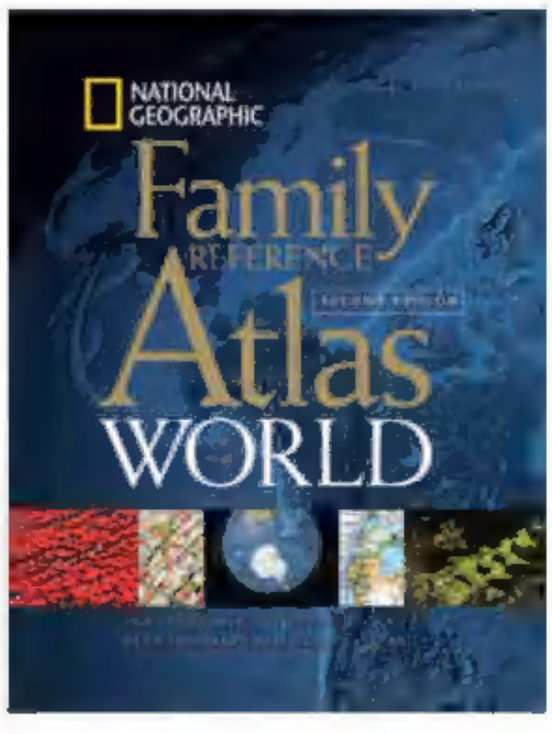
WildCam Grizzlies fish in Alaska's McNeil River in the summer (above), elephants quench their thirst at Pete's Pond in Botswana in the fall, and cranes swoop onto Nebraska's plains in the spring. *Ngm.com's* WildCam, helped by the National Park Service, the Mashatu Game Reserve, and the Audubon Society, captures it all with live video feed. This month, the action's at Pete's Pond. See it at *ngm.com/wildcamafrica*. To suggest more WildCam locations, go to *forums.ngm.com*.

On Fire He sent it in for Your Shot, the GEOGRAPHIC's new page of reader-submitted photos. But Thomas Cooper's image of a smoldering mountain near his Colorado home was so striking that editors decided to use it as one of this month's three Visions of Earth (page 14). "When I saw that the theme for Your Shot in June was 'Where I Live,' I realized I could submit that picture," he says. "I stayed up all night photographing that fire."

NG Books

Dragon Rising Beijing-based journalist Jasper Becker examines the world's most populous nation in *Dragon Rising: An Inside Look at China Today.* By exploring issues such as rural migration, modernization, and agricultural life in different regions of the country, Becker reveals where China has been and where it's heading ($35).

Family Reference Atlas of the World Where can safe drinking water be found in the world? What is the population of Guyana? Find out—and find more—in the second edition *Family Reference Atlas of the World.* The volume comes with more than a thousand maps and illustrations, new detailed insets, and a spread on Mars ($65).



PHOTOS: HARRY WALKER, ALASKA STOCK (TOP); JAY DICKMAN

FLASHBACK

Artist's Palette "We'd give him an assignment and pay his expenses, and he understood what we wanted," said a former NATIONAL GEOGRAPHIC editor about photographer Gervais Courtellemont. And "what we wanted" was color. Courtellemont had 24 Autochrome photo essays bloom from the largely black-and-white pages of the magazine between 1924 and 1932, among them "Color Contrasts in Northern Spain," "Along the Banks of the Colorful Nile," and "Rainbow Portraits of Portugal." This artistic idyll along the banks of France's Dordogne River was probably captured during the photographer's coverage of the October 1930 story "Beauty, History, and Romance Enrich the Château Country," but it was not included in that article. *—Margaret G. Zackowitz*

Flashback Archive All the photos plus e-greetings, in Fun Stuff at **ngm.com/0610.**

PHOTO: GERVAIS COURTELLEMONT

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On Canada's Hudson Bay in November, the boundary between land and water vanishes beneath a monolithic covering of ice that stretches as far as the eye can see. Here, in the frozen north, the sun never reaches its zenith and every day, the sun's passage across the sky grows shorter. Photographer Mitsuaki Iwago spotted a polar bear heading offshore in search of seals, rubbing its nose against the frozen ocean to sniff out its prey. Polar bears travel thousands of miles across the icy waters where the only sound is that of the wind. Thanks to Olympus digital technology, impressive scenes like this can now be frozen literally forever.

Shot at Cape Churchill on the west shore of Hudson Bay, on November 14, 2002, at 8:23 a.m., with the Olympus CAMEDIA E-20 digital camera, f6.3, 1/80 sec.

Digital SLR Camera OLYMPUS E-1

Global Warming Witness

The effects of global warming are already apparent in Canada's Hudson Bay. Representing the southern limit of the polar bears' habitat, Hudson Bay has been experiencing increasingly shorter winters, leading to earlier ice melt and forcing the bears onshore before they can fully replenish their reserves of fat by feeding on the seals which live on the ice. Typically, a polar bear will stake out a seal's breathing hole, attacking the animal when it sticks its head up for air. A shorter hunting season limits the ability of females to feed their cubs, reducing their survival rate. As of 2006, polar bears have been designated a vulnerable species.

Visit the "Global Warming Witness-Iwago Mitsuaki" website at:

http://www.olympus.co.jp/gww/

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